Power and The Engineer

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WITH this issue we introduce a new form of heading and wish to call your attention to its advantages.

No engineer can be vitally interested in *all* the details of *all* the various branches of steam engineering.

He *is* vitally interested in *all* the details of some one or of several branches.

He wants to keep posted in his particular line and know in a general way about other things.

This new heading was invented for just this purpose:

To tell him briefly all about the general things in engineering, and to tell him explicitly about those things he is interested in most.

If you cannot stop to read a circumstantial account of the progress of power plant engineering from week to week, you can at least read the log and know where you are and where and how fast you are going.—This is the log.

Each important article will have a brief summary in a frame under the title—read them and you will know, in a general way, of everything that is doing in the whole broad field.

Then, when you come to the article that is bread and butter to you, read it all.

No one but a hermit or a prisoner reads all of a daily paper—it is skimmed.

POWER AND THE ENGINEER costs less than four cents a week—read it right.

This new plan will save time—your time—prevent you from overlooking anything you ought to know, and will get you right down to brass tacks on those things you can't afford to miss a word of.

Many a good thing has been printed in vain because its heading did not tell what it was all about, and many another because it looked hard and was laid aside for Sunday or some other time.

Make the editors tell you in these *tabloids* what you want to know. If they don't, send in a kick—a postal card will do the trick.

This is your paper; if it hasn't something on every page to interest, instruct, help and encourage some engineer, it's missing its work.

When you go to a ball game and the umpire puts out Ty Cobb when you think he was in fair, you yell "rotten"—hand it to the editors if they don't "play ball according to Hoyle."

POWER AND THE ENGINEER has got to get results—with you—and be pleasing to take at the same time.

The college president who said "an educated man is one who knows a little about everything and *all* about something," did not mean college graduates only; he meant all of us—and if the steam engineers of this country are not some of *us* with a big U, who is?

Richmond & Chesapeake Bay Plant

By Warren O. Rogers

Originally this plant consisted of three 1000-horsepower steeple compound engines, connected to direct-current generators. Later two units of the same capacity and type were added and low-head waterwheels of equal power were coupled to the shafts of the five generating sets. Normally the waterwheels drive the generators, but at times of low water the engines are called into service. In either case the idle prime mover is uncoupled from the shaft.

This plant is not new by any means; in fact, the original installation was briefly described nine years ago in POWER, but the plant today contains many features not incorporated in the original installation and not found in any other power plant, to the writer's knowledge.

The original plant consisted of three 1000-horsepower Allis steeple compound engines, that is, the high- and low-pressure cylinders were placed one above the other, the high-pressure cylinder being on top. Not long after the first installation, two more engines of the same type and capacity were installed, the intention at that time being to equip the entire plant, as the power demands necessitated, with this type of unit. These engines are direct connected to General Electric direct-current generators, the original three units having a capacity of 1187 amperes at 590 volts. The two engine-driven generators last installed have a capacity of 1270 amperes at 590 volts. All five units run at a speed of 110 revolutions per minute.

As the water of the James river could be utilized by diverting its course through a canal, these five engine-driven generators were connected by means of shaft couplings bolted together, each to a 1000-horsepower Victor waterwheel working under a head of 25 feet with average water conditions. Three of these waterwheels are each governed by means of a Lombard waterwheel governor; the last two units by improved Holyoke waterwheel governors.

When the water is at such a stage as to admit using the waterwheels, the engines are disconnected at the crank, and the brasses and straps removed. The connecting rod of each is allowed to hang from the crosshead which is blocked up, with the piston at the upper end of the cylinder. The eccentric straps and rods are allowed to remain in place, but the valve gear is disconnected at the rocker

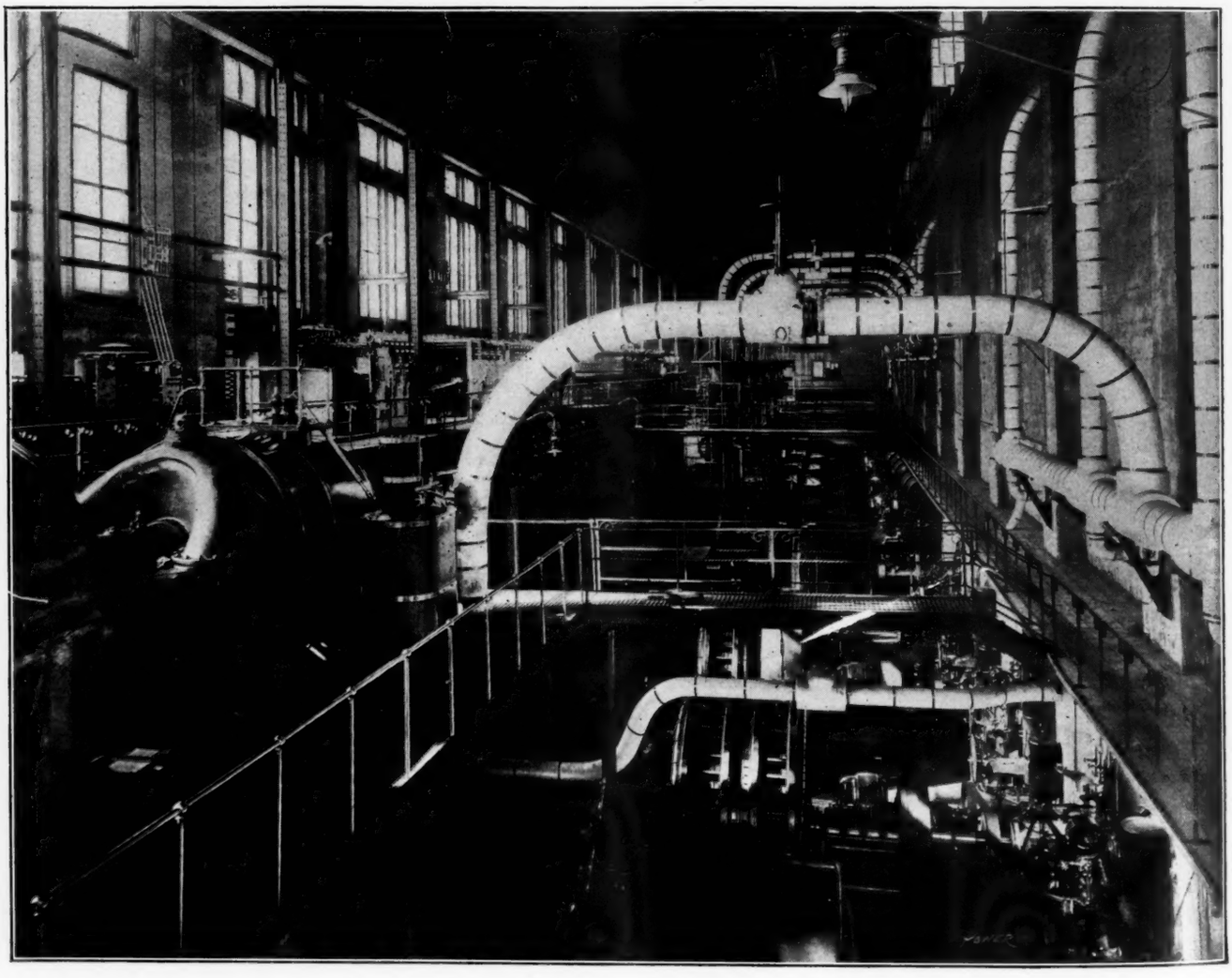


FIG. 1. GENERAL VIEW OF ENGINE ROOM

arms and the wristplates of the valve gear are blocked up in their highest position. When it is necessary to change from water to steam power, the reach rods are connected to the rocker arms, and while one set of men are attending to this part of the work, another set are working on the connecting rod, the work requiring from one-half to three-quarters of an hour.

Double Generating Units

These five units were soon found to be insufficient to carry the load and, therefore, several waterwheel-driven generators were installed, as needed. These units are arranged with various combinations of generator on the same shaft. For instance, unit No. 6 consists of two General Electric direct-current generators, direct connected to the waterwheel shaft, and mounted on the same base. Each machine has a capacity of 1509 amperes at 265 volts, and is run at a speed of 110 revolutions per minute.

Unit No. 7 consists of an Allis-Chalmers three-phase 60-cycle alternating-current generator, running at a speed of 128½ revolutions per minute. Only one machine is driven by this waterwheel, which is governed by a Sturgess governor.

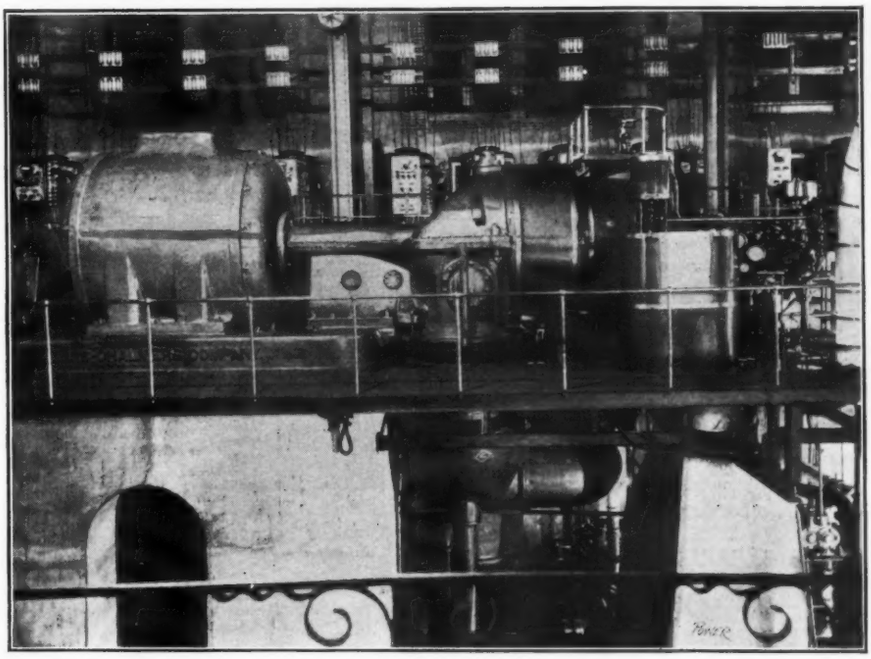


Fig. 3. Allis-Chalmers Turbine Unit

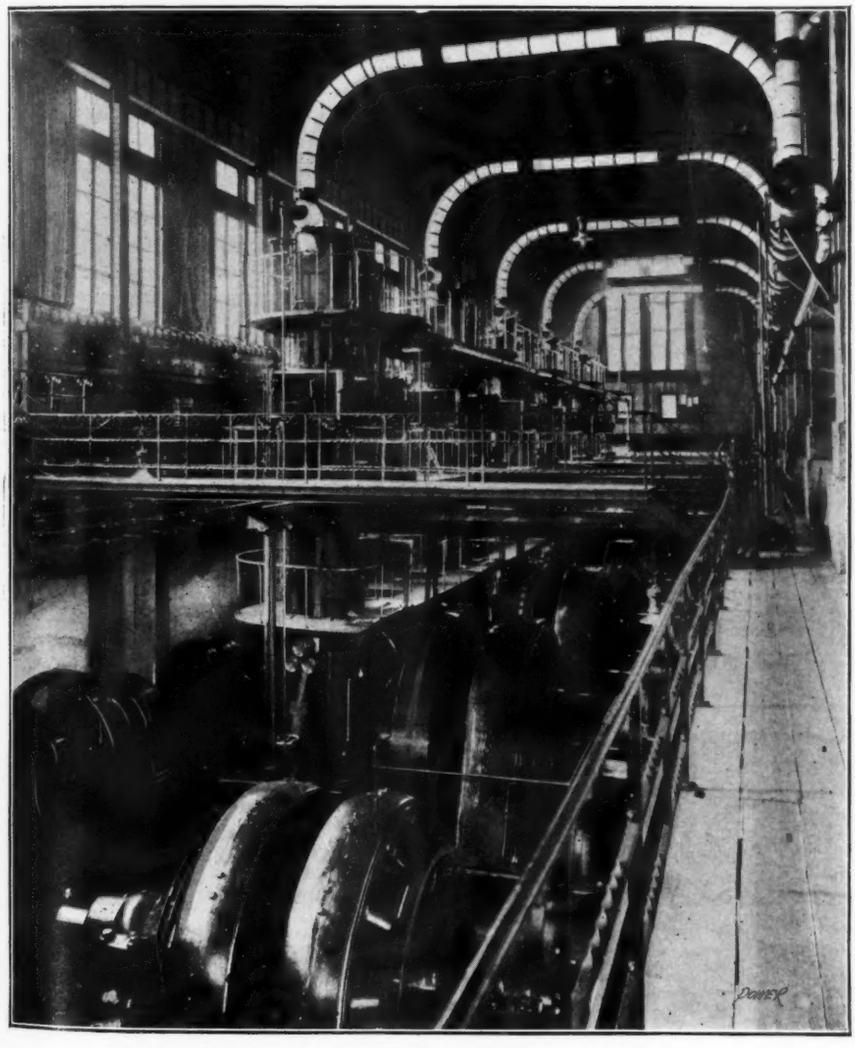


Fig. 2. Steam-driven Units

No. 8 unit consists of a General Electric direct-current generator, having a capacity of 1270 amperes, full-load voltage 590, running at a speed of 128½ revolutions per minute. On the same shaft is a three-phase 25-cycle General Electric alternating-current generator, operating at a voltage of 6600. The waterwheel is of Leffel make and is governed by a Sturgess governor.

No. 9 unit consists of two General Electric three-phase 6600-volt alternating-current generators supplying 66 amperes; the speed is 128½ revolutions per minute. These machines also are direct-connected to a Leffel waterwheel controlled by a Sturgess governor.

No. 10 unit consists of a Holyoke waterwheel, direct connected to a General Electric alternating-current generator having a voltage of 12,300, the speed being 120½ revolutions per minute. This waterwheel is governed by a Holyoke improved waterwheel governor.

Besides these generators there are several smaller motor-driven units arranged in suitable locations on the main floor under the switchboard gallery. The waterwheel governors are all arranged on the side next to the waterwheels, as shown in the general arrangement of the plant.

Fig. 2 shows a view of the steam-driven units being operated by water power, also the location of some of the motor-driven generators.

Turbine Set

The latest unit to be installed is a turbine-driven three-phase 60-cycle 2300-volt alternating-current Allis-Chalmers generator, running at a speed of 1800 revolutions per minute. It is set on a concrete foundation constructed so as to permit placing an Alberger jet condenser directly under the turbine. The

condenser is connected to a 12 and 22 by 18-inch Alberger dry-vacuum pump, also a 20-inch Alberger volute pump, which is direct connected to a Fleming-Harrisburg outside-crank steam engine, and runs at a speed of 185 revolutions per minute. By this arrangement of the

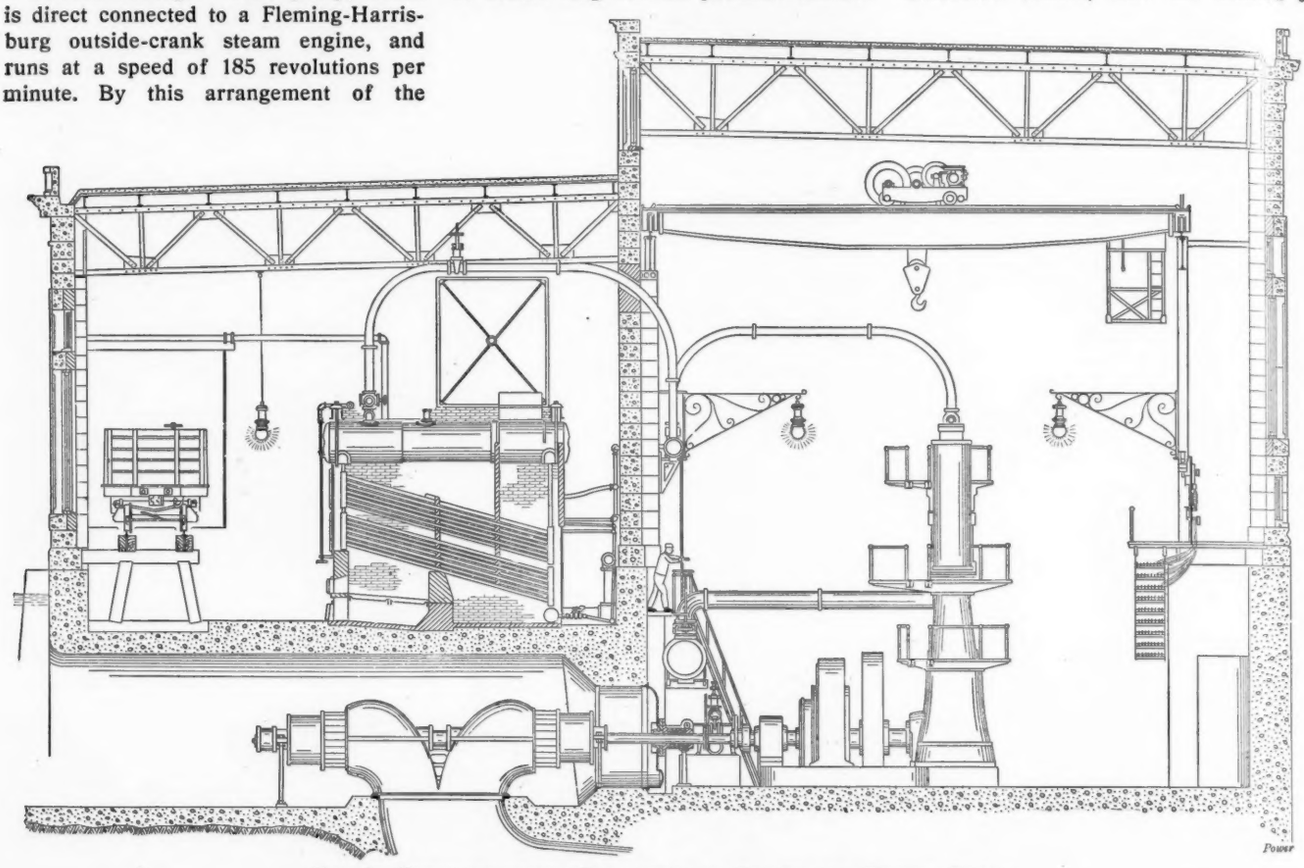


FIG. 4. CROSS-SECTIONAL ELEVATION OF BOILER AND ENGINE ROOMS

foundation, the turbine is on a level with the switchboard platform, which extends the entire length of the generating room, as shown in Fig. 1. A view of the turbine is shown in Fig. 3. Another turbine is soon to be installed, with the boilers necessary to supply it with steam. The new turbine will be placed beside the present turbine unit and the new boilers will occupy the space shown in the far end of the boiler room, Fig. 5, which is now used as a machine-repair shop.

BOILER ROOM

Located in the boiler room are four batteries of Babcock & Wilcox water-tube boilers, three of the batteries having two boilers each; the remaining battery consists of three boilers. Six of the boilers are of 500 horsepower capacity, and carry 150 pounds pressure. These boilers are fitted with 252 four-inch tubes, each 18 feet long. Each boiler occupies a space 21 feet wide, 12 feet high, and is fitted with three 42-inch drums, each 20 feet 4 inches long and made of 7/16-inch plate. None of these boilers are equipped with superheaters, as they supply steam for operating the reciprocating engines.

The three new boilers are of 600 horsepower capacity, each containing 294 four-inch tubes, 18 feet long. Each boiler is 21 feet long and 14 feet high and is equipped with three 42-inch drums, made of ½-inch plate. The drums are 21 feet 11 inches long and the pressure allowed is 200 pounds per square inch. These three boilers are equipped with Foster superheaters.

Two separate headers supply steam to the reciprocating engines and turbine, each header being connected to its respective boiler unit by long-radius bends, as shown in Fig. 4.

Fig. 5 is a view of the boiler room, showing the general arrangement of the hand-fired boilers, also the method of delivering the fuel. The coal is delivered to the boiler room in the regular type of railroad car, on a trestle which runs the entire length of the room, thus eliminating the work necessary in many steam plants of rehandling the fuel supply. The track is about four feet above the boiler-room floor.

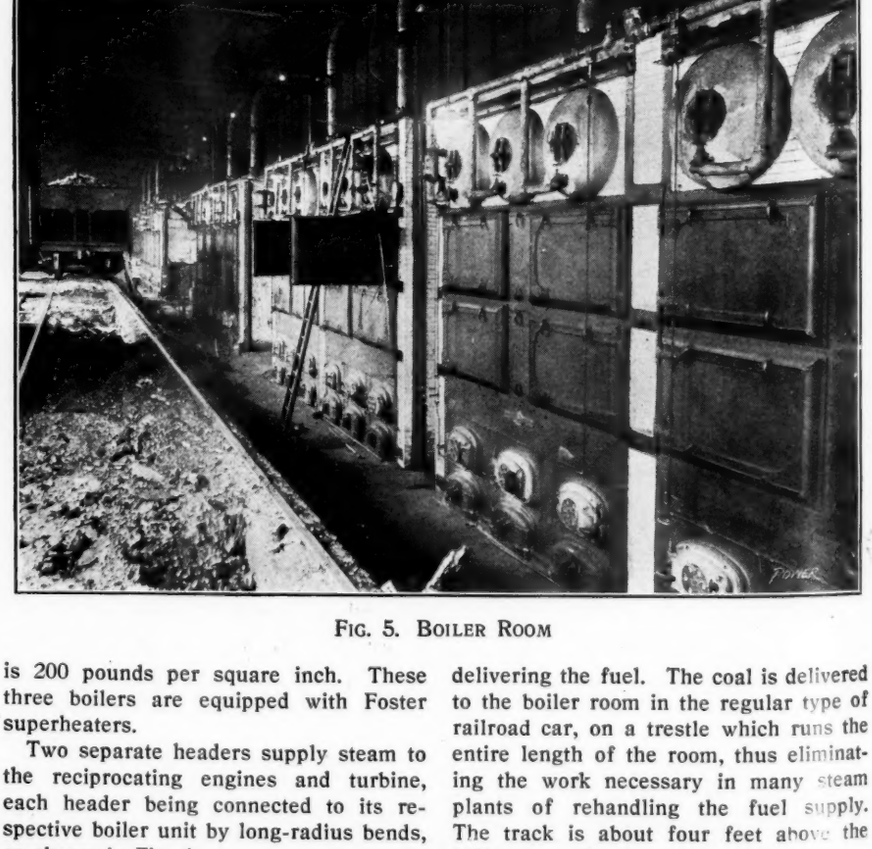


FIG. 5. BOILER ROOM

Ice Troubles in Water Power Plants*

By W. von Winkler

Leaves, sand and debris are often a source of annoyance when operating water turbines, but snow and ice form more dangerous admixtures with the water. There are three kinds of Ice: raw, ground and shell ice. The raw surface ice in needle-like form sticks with great tenacity to iron and is more difficult to avoid than the ground or shell ice.

Many theoretical constructors assume that they have only to deal with "water," which will behave itself as such, whereas practice really discloses materials which deport themselves quite otherwise than to merit the name "water." To the turbine are attributed evils for which it is not responsible, but which are due to the substances entering it.

It may be well to consider a few of the methods which are resorted to for cleaning the water. In waters of small heads, especially in the central Alps where primitive rock prevails, there is commonly encountered a fine mud, which is deposited where the water decreases in velocity. In the higher falls there is found instead a fine abrasive sand, which seriously erodes and grooves the turbine.

Coarse iron racks reveal the presence in the water of stones, properly so called, of several decimeters in diameter. These usually are not very dangerous, since they are deposited in places where the streams broaden and deepen. However, if they are small or flat they sometimes are carried along and cause trouble.

Leaves which fall into the water during autumn can be kept out of the turbine while they are dry and float on the surface, but when they become saturated they are not so easily avoided and they sometimes put water wheels out of service by clogging up the conduits and narrow places. If the rack is fine enough to exclude them, it will be difficult and expensive to keep clean.

By far the most important and dangerous admixtures with the water are snow and ice. The latter is a normal phenomenon; the former enters only under special conditions, but it can work disastrously.

Raw Ice

Of ice, may be distinguished three forms, which are known by a variety of names. Raw ice is formed on that part of a water course where it is exposed to the cold north and northwest winds, and where its velocity is lessened, as for instance in the forebay. When in a sharp, cold wind the water has been progressively cooled without injuring its transparency, we may observe how, suddenly, the entire surface quivers, forming in the top layer fine, pointed needles of ice, whose existence is too proved by examining samples of the water and which are also evident by the unfortunate fact that they accumulate with great vehemence and tenacity upon iron surfaces and cover them with a crystalline coating.

The needles also show an inclination to become tangled together and form a hard mass. It is evident that special phenomena and molecular forces here play their part.

A protection against this raw ice is extraordinarily difficult. It consists in cleaning the rack and temporary clearing of the turbine from ice.

Experiments with a view to obviating this evil by heat have resulted in no practical method. In plants where large quantities of water are used, the heating would cost more than if the electric current were generated directly by a steam installation. The quantity of raw ice produced depends upon the amount and surface temperature of the water, the covering of flake ice on the bed of the river, the exterior temperature and the strength of the wind.

The quantity in itself is not very great; the injurious properties of the raw ice are much more active when it is accompanied by ground ice which has risen after being freed by the sunshine and, a few hours later, in the evening or night, appears upon the middle or lower part of the plant appurtenances under water.

Ground Ice

The ground ice has an entirely different province and a different character from the raw ice. It forms on the bottom of the river by reason of the cold entering through the earth and often displays a mossy structure, since it is formed similarly to frost in the air. In contrast with the fine crystals of the raw ice, invisible in the water, it forms coarse white kernels and collects in great cloud-like shapes in the water, when released from the bottom by the sunshine. It is always mixed with substances found in the bed of the river, such as shells, moss and weeds. These kernels do not display such anxiety to collect on iron as do the crystals of the raw ice, nor do they form such strong crystalline masses, but they are nevertheless sufficiently inconvenient. A very practical method of lessening their influence, where the quantity of water is sufficient, consists in placing before the racks and in other advantageous positions, protective floats provided with a vertical wall jutting out into the water. Since the ground ice floats in nebulous masses, it is easily diverted by these vertical walls. A prerequisite, however, as mentioned, is sufficient water. Yet if there is not enough of this we are not necessarily restricted to the alternative of sending the ice through the turbines, and these may be so constructed as to take care of themselves quite well. It is very noteworthy how often in the construction of racks are found devices which, because of the presence of ice, are simply nonsensical and introduce great damage and difficulty. Of this sort, for example, is the use of iron racks with railroad-rail bars in rivers where great danger from the pressure of floods and tides does not exist. These grating bars conduct the cold of the outer air to the bottom of the stream and so encourage an increased formation of ice, which because of the irregular section of the bars is difficult to remove.

Suggestions to make the rack of wood are not favorably received by manufacturers, as they do not consider such construction uptodate. But the designers are apt to be tied down to theoretical precedents, whereas it is the experience of the practical use which should govern the case. Preference may be given to racks of round wood with tubular caps and holes with which they are revolvable by means of a pin. The ice formation upon them is slight, does not extend into the water, and may be satisfactorily removed by turning the bars through 180 degrees.

Truly disastrous is the incomprehensible method of stiffening the rack bar by transverse braces, right on the water line, as is often done.

Flake or Shell Ice

The third kind of ice is shell ice. It should be known that this ice forms in smaller quantities. Its effects are very serious; it gets through the coarse rack and in quite large sheets blocks up the fine rack, essentially lessening the free section of the latter. The only remedy now is to break up, at the fine rack, this shell ice which has not been diverted by the aforementioned floats, and to remove it with rakes. Shell ice forms in vari-

*Translated in abstract from *Die Turbine*, by E. P. Buffet.

ous, often very considerable, degrees of strength in the forebays also, and may cause the formation of an ice jam.

Toward the spring, when the water becomes warmer, the shell ice loosens from the shore and floats with the water toward the valley. It is then melted by the water but retains its shell form, almost to the last, although its consistency is essentially altered; it turns to slush, which generally, because of the higher temperatures, can have no disastrous effect. An exception must be made when the shell ice is augmented by snow and breaks up into soggy masses. These are worse than the ice itself because they are more difficult to handle with tools and afford insecure footing for the workmen. Many water-power plants are inadequately arranged for the removal of ice and snow. It is advantageous to have the overflow in a direct line from the forebay while the water for the turbine is led off at one side; this encourages the ice to take care of itself.

In the dimensions of the rack mistakes are made which lead to important consequences. Generally racks are too high or too narrow, which are inconvenient forms for cleaning by hand. Unfortunately, automatic clearing contrivances have not as yet been satisfactorily perfected.

The Stability of Chimneys

By E. W. Beardsley

The author gives graphic methods for determining the center of area and stability, also approximate rules for general proportions and taper. Figures on wind pressure are included and foundation design for brick and steel stacks is briefly considered.

A contracting mason's sketch for a proposed square brick chimney with a round flue was brought to me to make a drawing for record and reference. It looked light for its hight and the question of its stability came up. An interview with the mason who made the sketch proved it to be a splendid example of the designing of some "practical" men who, though experts in the handling and use of materials, have little or no conception of the principles of design in the structures which they build. I tried to approach the subject carefully and not offend the man, but he came out frankly with the declaration that he knew nothing about wind pressure. He had built many chimneys and had designed this one as light as he thought would do. Being a new problem to me, I naturally began to look up what "the books" said on the subject. A treatise on power stations stated that the resultant of the weight of the chimney and the wind pressure at 50 pounds per square foot of exposed surface should fall (as I understood it) within the limits of the center one-third of the base width. On this basis, and figured as a whole, the chimney in question was good for a wind pressure of only about 17½ pounds instead of 50. I found no authority sanctioning a reduction of the 50 pounds, so I thickened the shell and widened the base. This time it was good for about 25 pounds. I tried further increases until I was convinced that the rule was unreasonable and then I began over again.

I found that 15 tons per square foot was considered a reasonable pressure to allow on concrete and on brickwork laid in cement. I considered then the evident fact that the effect of the wind pressure is not to add to the total pressure on the foundation but only to move the center of pressure from the center of the chimney to the point where the resultant of weight and wind pressures intersect the bottom of the chimney. Further, I decided that the shell and core should be figured as separate structures because they were nowhere bonded together. After a little skirmishing along these lines, I carefully figured one which promised well.

Center of Area

On a tapered chimney the center of area is obviously not at the center of hight. It is obtained closely enough by this graphic method: Draw to scale the outline of the portion exposed to wind, as *A B C D*, Fig. 1. Draw the diagonal

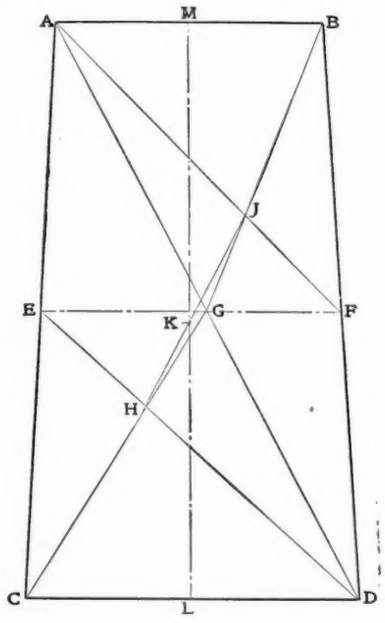


Fig. 1

A D. Draw *E F* at the center of hight, thereby bisecting *A C*, *A D* and *B D*. Draw *A F*, *B G*, *C G*, *D E*. The intersections *J* and *H* are the centers of area of the two triangles. Draw *J H*, intersecting the center line *M L* at *K*, and *K* is the center of area of the figure *A B C D*. Scaling the distance *K L* gives the hight from the base to the center of area. If the lower part of the chimney is inclosed, the line *C D* should be at the bottom of the exposed portion but *L* should always be at the base. Considering the total wind pressure as concentrated at the center of area and having figured the total weights of the shell and core separately, I started at the intersection of the center line of the wind pressure and the center line of the weight of the chimney and laid off *K P*, Fig. 2, equal to the weight of the shell on a scale of one-fortieth of an inch to one ton, and *P Q* to the same scale, equal to the total wind pressure. The resultant of these forces, *K Q*, produced to *T* at the base, fell slightly too far out. I then divided the weight of the shell, in tons, by two and then by 15, thereby obtaining the number of square feet of base area required outside of the center of application without exceeding the allowable pressure. Drawing a resultant, *K U*, through the inner line bounding that area, I obtained *P S*, scaling which gave the amount of wind pressure the shell would safely resist at the assumed values. Applying the remainder of the wind pressure, *S Q*, as *N P*, to the weight of the core, *K N*, I found, by similar methods, that it was good for that and a little more. The results in this case indicated that the rule which bothered me so might have meant the middle two-thirds instead of one-third of base width.

The Babcock & Wilcox Company's book, "Steam," calls for the external diameter of a brick chimney at the base as not less than one-tenth the hight. The "batter," or taper, should be from one-sixteenth to one-quarter inch to one foot on each side. Thickness of brickwork: One brick (8-inch or 9-inch) for 25 feet from the top, increasing one-half brick (4-inch or 4½-inch) for each 25 feet from the top downward. If the inside diameter exceeds 5 feet, the top length should be one and one-half bricks and if under 3 feet, it may be one-half brick for 10 feet. This book gives a formula for stability which seems to be very good for general application. The weight of the chimney in pounds should equal the average breadth of the chimney multi-

plied by the square of the hight (in feet) and divided by the breadth of the base and then multiplied by 56 for a square chimney; 28 for a round one or 35 for an octagonal one. (These figures evidently being wind pressure.) It should be noticed in this connection that a round chimney close to the side of a building, or other structure, which would retard the wind, should be considered as receiving the same pressure as a square one for the hight of the structure on the half-diameter next to it.

An out-of-print English book, entitled "Tall Chimney Construction," by R. M. and F. J. Bancroft, states that "it is found in practice advisable to limit the deviation of the center of pressure from the center of figure so that the maximum intensity shall not exceed twice the mean intensity." The ratio of the above deviation to length of base is given as one-third for square chimneys and one-quarter for round ones. I imagine the rule which troubled me so was intended to convey this meaning in different words, but it did not. The ratio of wind pressure to projected area of chimneys was

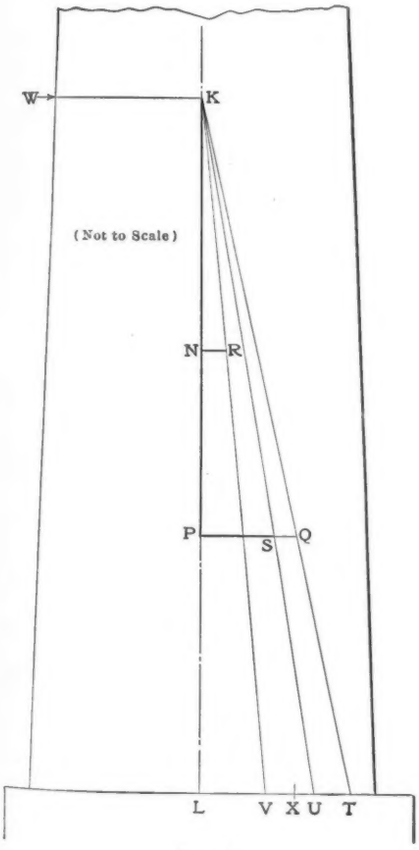


FIG. 2

given as 1 on square, 0.75 on octagonal, 0.50 on circular chimneys.

A book on chimneys by W. W. Christie, seems to be the only one of its kind in print. He quotes from Rankine that, by observation of chimneys which respectively stood and fell during the violent storms of 1856, the weight of a round chimney should be such that a wind pressure of 55 pounds per square foot shall not cause the resultant pressure at any bed joint to deviate from the axis of the chimney by more than one-quarter of the outside diameter at that joint. The greatest wind pressure observed in Great Britain is 55 pounds per square foot. The greatest observed in the United States was in the St. Louis, Mo., tornado which has been "calculated to have been about 90 pounds per square foot." It was reported by a United States engineer that during the Galveston, Tex., tornado, in 1900, the wind velocity reached 100 miles per hour, which would give a pressure of about 50 pounds per square foot. It is the general practice in the United States to assume 50 pounds per square foot as the maximum.

The London Building Act, 1894 (Fowler's Pocketbook), contains the following requirements for "Furnace Chimney Shafts:" A taper of at least 2½ inches in 10 feet of hight. The thickness of brickwork at the top and for 20 feet below the top shall be at least 8½ inches, and shall be increased at least one-half brick for every additional 20 feet. The width of the base, if square, shall be at least one-tenth the hight and if round, or any other shape, then one-twelfth the hight. (The one-twelfth, I imagine is a misprint, as one-eighth would seem a more proper proportion.) Any firebrick built inside the lower portion shall be provided as additional to and independent of the thickness of brickwork prescribed by these rules and shall be bonded therewith.

These general rules are seen to be only approximations, although they are mostly safe, I should judge, but sometimes may not be as economical as one figured in the manner outlined, which I consider to be fully accurate enough for ordinary use. I used 125 pounds per square foot as the weight of both brickwork and concrete, and, according to common engineering usage, 2000 pounds for one ton.

Care must be taken to have the chimney walls sufficiently strong where openings are made above the foundations. The pressure can be figured at an opening in the same manner as at the base, assuming a joint through it. The maximum pressure should be assured to be on the same side as the opening.

FOUNDATIONS

It was then necessary to design a foundation for the chimney. Assuming a possible foundation, I determined the number of square feet of bearing surface required outside of the vertical plane through *X*, Fig. 2, to carry one-half the total weight of the chimney and also the weight of that portion of the foundation. I corrected the design and refigured until I had a small excess of area. The point *X*, Fig. 2, is where the combined forces along lines *K V* and *K U* may be considered as concentrated. It is found in the following manner: Add together the weights (in tons) of the shell and core. Divide the distance *V U* (in inches) by the sum. Multiply the quotient by weight *K P*. Add the product (inches) to *L V*

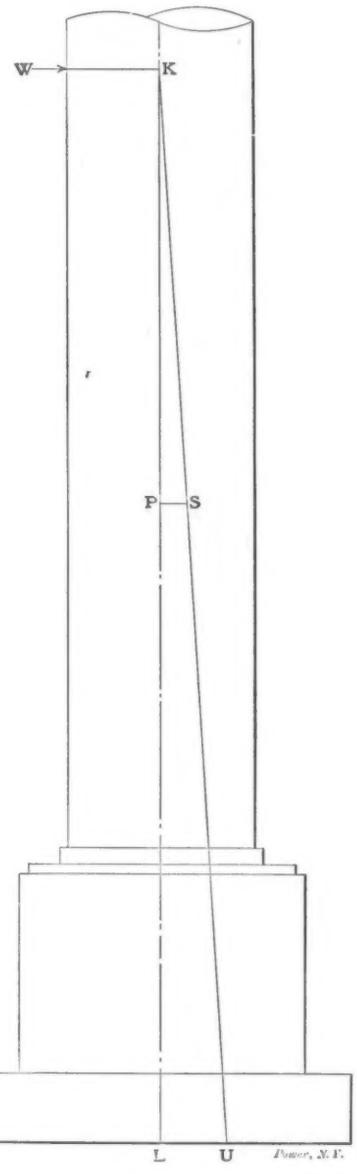


FIG. 3

and the sum, *L X*, is the distance to the point at which the total weight of both shell and core may be considered as concentrated on the foundation when the wind pressure is maximum.

The entering flue came into the foundation and too close to the top for the concrete to distribute the load, so steel I-beams were figured to carry the load over the opening. These had to be extended to what looked like an unreasonable distance each side of the opening to obtain sufficient bearing surface under them. The farther they were extended, the more load, from directly above, was carried, and the required area under them thereby increased. Cast-iron plates were used

both above and below the beams, to obtain bearing for the full width of wall.

In many cities there are building laws which specify the allowable pressures on brickwork. As these vary considerably, it is desirable to look them up if the chimney is to be built in a city. Kidder's pocketbook gives the following legal pressures, in tons per square foot, for hard-burned brick laid in portland cement: New York, 18; Chicago, 12½; St. Louis, 15. In natural cement: Boston, 15; Buffalo, 9; Philadelphia, 15; Denver, 9. Kidder recommends as safe working loads for masonry the following:

	Tons per Square Foot.	
	Eastern.	Western.
Red brick in lime mortar	7	5
Red brick in hydraulic lime mortar		6
Red brick in natural cement mortar, 1 to 3	10	8
Arch or pressed brick in lime mortar	8	6
Arch or pressed brick in natural cement	12	9
Arch or pressed brick in portland cement	15	12½

These figures seem low in the light of the results of very careful experiments conducted under the direction of, and recorded by Kidder, but they are not so high when the element of time is considered. If a foundation could be prepared a year beforehand and another year consumed in the building of the chimney, or if the occurrence of a high wind could be prevented for a year after the building of the chimney, then 15 tons, or more, might be perfectly safe. Where the work is carried on as rapidly as is common, from the building of the foundation to the completion of the structure, it is plain that the concrete and the cement mortar can hardly have reached their full strength as soon as there is the possibility of its being required.

The pressure on the soil under the foundation must be carefully considered. In his book before mentioned, W. W. Christie gives the following bearing values of soils, in tons per square foot, in ordinary practice:

Quicksands and marshy soils	½
Soft and wet clay	1
Clay and sand, 15 feet thick, or more	1½
Pure clay, 15 feet thick, or more	1½
Pure dry sand	2
(The last three from Chicago building laws.)	
Pure dry sand, in natural bed	2
Pure dry sand, well packed and confined	4
Good, solid, natural earth (N. Y. laws)	4
Pure clay, 15 feet thick, or more	4
Gravel, well packed and confined	8
Rock, broken but well compacted	5 to 25
Solid bed rock	200

Piling must be used when the soil is very sandy or loose.

The Passaic Steel Company gives in its manual: Soft friable rock, 5 to 10; compact bed rock, if of sandstone, 18; if limestone, 25; if granite, 30.

Fowler's Pocketbook notes that in porous soils foundations should be well drained.

In spreading out the foundation from the top downward, when the maximum strength is required, an offset should be not more than three-eighths of its thickness, if brickwork in portland cement, or one-half its thickness if concrete. Neither of these materials should be loaded more than 200 pounds per square inch. (Passaic Steel Company.) This is slightly less than 15 tons per square foot.

In increasing the foundation base, there is commonly an addition at the corners, equal to a square of the width of the strip added, that is liable to be overlooked in hurried figuring. On large foundations this becomes a noticeable amount.

When the character of the soil is not known, specify on the drawing the maximum pressure required, as drawn, that the foundation may be increased if the soil is found of less value.

Steel Stacks

In designing foundations for self-supporting steel stacks, I have required that the foundation bolts run practically to the bottom of the concrete and then have figured the steel shell, firebrick lining and foundation as one structure, with the forces acting on the bottom surface of the foundation. In Fig. 3, KP equals the above total weight and PS the total wind pressure, making allowance for the shape of the stack.

Swinging dampers at the tops of stacks should have a rigid connection at the top surface of the damper and not a pivoted one. I have seen a bolt from one of the latter type, which had been cut about one-half through in a year or so by the see-sawing action of the wind on the cover. The means for supporting the damper lever also need careful attention. The upright should be riveted to the shell, outside, and with from three, on a very small one, to six or eight rivets or bolts on a large one. I have seen brackets for supporting a 70-inch damper which would hardly have been sufficiently stable for a 17-inch one, and I have seen one on a 40-inch damper which was plenty strong enough for the 70-inch one.

A sketch of the special lining bricks sometimes used might prevent such a blunder as I knew of a brick manufacturer making, which required the replacing of a large shipment of bricks which had been made with the figures for the hight and the thickness reversed from what was ordered.

Large DeLaval Turbine in Sweden

One of the largest steam turbines in Sweden has recently been built by the De Laval Steam Turbine Company, of Stockholm. This unit has been installed at Varberg in the Yngeredsfors power station, which is used as a reserve steam plant to the Yngeredsfors water-power station. This extra outlay was deemed necessary on account of the greatly reduced supply of water available at certain times of the year.

The building housing the machinery of this station is placed close to the harbor, and is of the most modern and improved construction. The above mentioned company supplied the equipment of the entire plant, subletting the work of installing the boilers, generators, motors, etc., which were supplied by the Munkell Engineering Works, Eskilstuna, and the General Swedish Electric Company. The steam turbine is of 2750 horsepower capacity, and is direct-connected to an 1875-kilowatt three-phase generator with direct-coupled exciters. The speed is 1500 revolutions per minute.

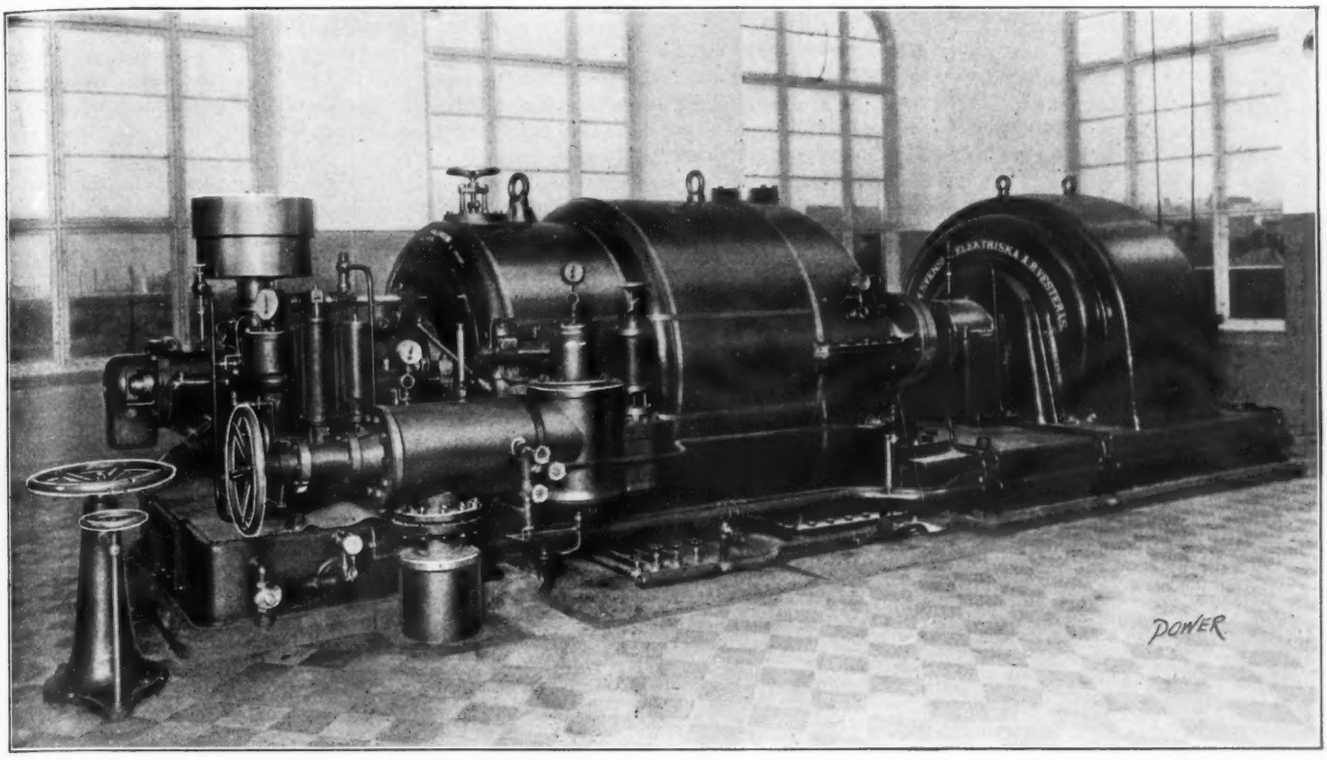
2750-horsepower condensing De Laval turbine installed at Varberg as reserve to water-power station. With water-tube boilers fitted with superheaters coal consumption is 1.98 pounds per kilowatt-hour.

Although the turbine can deliver continuously 2750 horsepower, it is accomplished at a greater steam consumption per horsepower output than when delivering 2250 horsepower, which is the output of the machine at its most economical point of operation, running condensing. When running noncondensing, the turbine can develop 2000 horsepower.

SUMMARY OF TRIALS AT VARBERG.

	Normal Load.
Steam pressure in boilers, lb. per sq. in.	169.2
Superheat in boilers, deg. F.	212
Draft, in	0.63
Coal per hour, lb	3,839
Evaporation of water per lb. of coal, lb	6.73
Feed water before heating, deg. F.	45.5
Feed water after heating, deg. F.	63.5
Steam pressure above the governor valve, lb. per sq.in.	167.2
Steam temperature above the governor valve, deg. F	541.5
Superheat above the governor valve, deg. F	167.8
Steam pressure under the governor valve, lb. per sq.in.	157.6
Revolutions per minute (about)	1,500
Vacuum (reduced to 760) 94.92%	28.49″
Kilowatts	15.70
Steam per kw.-hour, lb.	16.47
Coal per kw.-hour, lb.	2.448
Generators degree of efficiency	0.94
Brake horsepower	2,238
Steam per brake H.P.-hour	11.64

At subsequent test coal consumption of 1.98 pounds per kilowatt-hour was obtained.



2750-HORSEPOWER DE LAVAL TURBINE

The surface condenser contains 4300 square feet of cooling surface. There is an electrically driven triplex air pump which has no suction valves, also a condenser pump and circulating pump of the De Laval Zeta type. The centrifugal pump is directly coupled to a 50-horsepower three-phase 800-volt motor. By means of gears, the air pumps and condenser pumps are driven by the same motor. When the turbine is being operated noncondensing the condenser is protected from the steam by a valve placed in the exhaust pipe between the condenser and turbine, and the exhaust escapes through an atmospheric relief valve which opens automatically when the steam pressure in the exhaust pipe exceeds one atmosphere.

The boiler plant consists of two Babcock & Wilcox water-tube boilers, each having 4730 square feet of heating surface. Although no economizers have been installed, room has been reserved for their installation, should it become necessary. The boilers are fitted with superheaters, and are equipped with mechanical stokers. The pressure carried is 170 pounds per square inch. The result of tests conducted at Varberg are given in the accompanying table, the coal consumption figures being of particular interest.

Two more De Laval turbines will be installed before the end of the present year, each of 3750 horsepower capacity.

Transmission of Power by Belts*

By Reginald Krall

In Europe thin steel bands have been successfully used as belts. Advantages claimed are shorter drives, lighter shafting, narrower pulleys and higher speeds, which are modified by difficulty in forming joint and in obtaining uniform quality of steel. The Lenix system, in which an idler automatically increases arc of contact with the load is another improvement in belt transmission which prolongs life of belt and permits of shorter drives.

In Germany and Belgium a recent development in power transmission is the use of belts made of thin steel. These belts are made from 0.008 to about 0.035 inch in thickness, and from about 0.087 to approximately 8 inches in width.

A trouble, which was at first encountered, was the liability of the belts to break due to unevenness in the quality of the steel. This is being rapidly overcome by the use of a specially manufactured steel of high temper. The construction of a suitable joint was another matter which at first occasioned difficulty. An ideal drive would naturally be obtained by the employment of a continuous steel band, but there are many difficulties in the way of producing such a belt, and its cost would probably be prohibitive.

Originally, the joint was made in such a way that the belt had to be soldered while in place on the pulley, but this method has been improved upon. With the joint in present use, which is shown in Fig. 1, the necessary soldering is done at the belt factory by trained men; the user has only to put the belt in position and insert a few screws. This is very important because it is necessary, in order to preserve the temper of the steel belt, that the solder shall be of a low melting point, not exceeding 390 degrees Fahrenheit. In Fig. 1, *A* is the steel driving belt, *B* and *C* are the two halves of the lock, *D D* are two small triangular filling pieces, *E E* are two rows of small screws, securing these triangular pieces to the belt and the locking pieces *B* and *C*; *F* is one row of large screws uniting the locking pieces. All that has to be done to fix the belt in position is to insert the screws *F* which have already been prepared by the manufacturer. It will be noted that the ends of the locking pieces *B* and *C* are prolonged. It

*Abstract of paper presented before the Junior Institution of Engineers.

was discovered that when these extensions were not provided, the belt would break near the small triangular pieces *E D* just after leaving the pulley, probably owing to the rapid straightening of the belt after its rapid motion over the pulley.

A curve is given to the under surface of the joint.

FIG. 1. JOINT FOR STEEL BELTS

For the determination of the length of the belt, a special apparatus has to be used, by which a light tape of steel is drawn over the pulleys and subjected to a predetermined tension, the two ends being drawn up together and caused to overlap; both ends are then cut through at the same point and a band the exact length of the belt required is thus obtained.

These steel bands run quite well on bare pulleys, but after a time there is a tendency to polish the surface of the pulley, and it is therefore desirable to cover the pulley with a very thin cork covering, which is glued onto canvas and in turn cemented to the pulley. In properly designed drives there is absolutely no slip, that is, no slip that can be detected. In practice, this is proved by the fact that the cork covering does not wear away.

Belts of steel appear to offer some considerable advantages over those of other materials. They do not stretch, and therefore never have to be taken up. For the same reason, no tension is required for allowance for stretch. As compared with ordinary practice, very much narrower belts can be employed, varying in width between ⅓ and 1/10

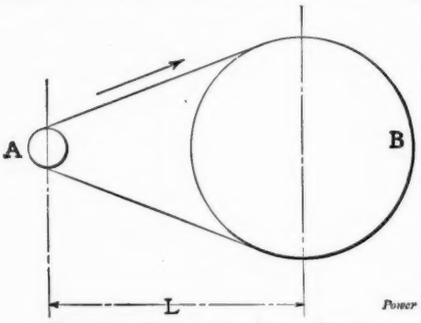


FIG. 2. ORDINARY BELT DRIVE

of that of an ordinary belt, which saves very much in cost of installation. Very high speeds, up to 10,000 feet per minute, may be employed. The belts do not appear to wear. The pull on the bearings and the wear thereof are reduced. Short drives may be used.

On the other hand, the material may not prove to be sufficiently reliable, but, as already pointed out, its unreliability is speedily being remedied. Another point is, that unless properly guarded, steel belts might prove to be very dangerous if they broke when running at high speed. The necessity of having to be careful about the exact length may also prove troublesome. These belts must be extremely well applied to insure the power being evenly distributed over the width of the band and to avoid any tendency to split the band.

Although this method of driving by steel belts is too new fully to have established its claim to general adoption, some thousands are already in use, and there can be no doubt but that the system will be regarded as of very great importance in the future.

THE LENIX SYSTEM

Another form of belt driving, in which belts in common use are employed, is the invention of Captain Leneveu, a French artillery officer, and is known as the Lenix system.

It is generally agreed that short drives by belts, vertical drives or large speed ratios should be avoided. Captain Leneveu, however, has demonstrated that with his Lenix system, the closer the two pulleys are together, the better the drive; that vertical drives may be made as efficient as drives in any other direction, and that his system possesses many other advantages.

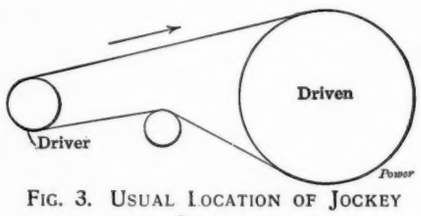


FIG. 3. USUAL LOCATION OF JOCKEY PULLEY

The Lenix system has met with much opposition, which is largely due to the fact that what might be described as a jockey pulley is used, which, as usually employed, is well known to be detrimental to the belt; but the manner in which the jockey pulley is used with the Lenix system is so different that the ordinary experience with jockey pulleys is no guide to the merits or demerits of Captain Leneveu's system.

Assume an ordinary belt drive, as in Fig. 2, where *A* is the driving pulley and *B* the driven pulley. If the ratio of the diameter of *B* to the diameter of *A* is large, it is necessary to make the distance *L* large also, and further, to provide that the top side of the belt shall be the slack side, because it is essential to secure as large an arc of contact of the belt on the small pulley as possible; otherwise, the belt must be drawn up very tight to prevent slip. In the case of a very short drive, in which the belt will naturally slip very much, what is often done is to jam a jockey pulley anywhere on the tight side of the belt, as in Fig. 3, so that the tension of the belt is increased until the slipping stops or the belt breaks. A jockey pulley in this position does not increase the arc of contact to any extent. All that it does do is to increase the tension in the belt and this increases the frictional effort at the expense of the belt.

A better though more unusual position for the jockey pulley is on the slack side of the belt as near the small driving pulley as possible, as is shown in Fig. 4. Here the arc of contact is increased as well as the tension in the belt; the arc of contact is naturally the most important factor. This arrangement of jockey pulley might perhaps be satisfactory if the conditions remained absolutely constant, that is, if the belt was without any stretch and the power transmitted was absolutely constant. In practice, however, these ideal conditions never exist, and even in the best cases of the employment of ordinary jockey pulleys, a bad drive is improved only at the expense of belts, bearings, etc.

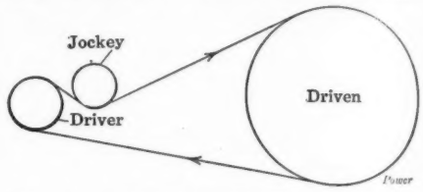


FIG. 4. IMPROVEMENT IN LOCATION OF JOCKEY PULLEY

In the Lenix system, the jockey pulley is placed on the slack side of the belt as near the circumference of the smaller of the pair of transmission pulleys as is practicable. The Lenix pulley is not fixed but is carried on an arm which rotates about the same center as the smaller of the driving pulleys, as shown in Fig. 5, and thus it floats on the belt. Just such a weight as will give sufficient tension on the slack side of the belt to prevent slipping is carried by the arm, the tension being regulated by the leverage to which the weight is set. A very large arc of contact is obtained, and very little tension is required in the slack side of the belt to transmit the power, usually about one-tenth of the circumferential driving force being sufficient.

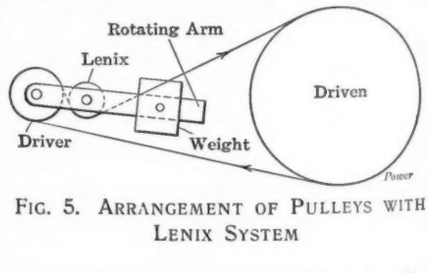


FIG. 5. ARRANGEMENT OF PULLEYS WITH LENIX SYSTEM

When the power to be transmitted increases, the tension on the tight side of the belt increases, and some of the material is transferred from the tight to the slack side of the belt, increasing the length of that side with the immediate results that the Lenix pulley drops and

takes up the slack, at the same time automatically enrolling the belt further onto the smaller pulley and insuring a greater arc of contact for the greater power being transmitted.

Another advantage of the Lenix system is that it overcomes those troubles in ordinary belt drives due to centrifugal force which causes the belt to leave the surface of the pulley, thus diminishing the contact and allowing slip to occur unless the initial tension is sufficient to prevent it. Owing to the action of this force, it is not often possible to use heavy belts at high speed.

Quite apart from the theoretical tension that exists in a belt, due to the

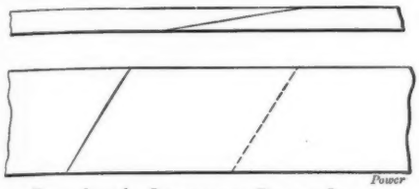


FIG. 6. A LEATHER BELT JOINT

power transmitted, it is necessary in almost every case to provide an initial tension to allow for stretching and the consequent slip. This tension may be as much as five, six or even ten times as great as the actual circumferential driving power. The belts, shafts, bearings, etc., have accordingly to be designed to support such a tension. With the Lenix system, the tension of the slack side of the belt need only be one-tenth of the circumferential driving force, and thus the tension on the tight side is only 1.1 times this same force. In practice, belts of the Lenix system have been designed for twice the circumferential driving force and have proved entirely satisfactory. Extremely light belts may, therefore, be employed. In some cases the adoption of the Lenix system has resulted in the use of belts only one-quarter as large in section as those previously necessary for the same drive.

Apart from this, a still greater economy is obtained in length, as the driving pulley and the driven pulley may be close together, the only space required being room for the Lenix pulley, 20 inches between the rims of the two being ample. This means economy in floor space, and indeed where motor driving is employed, it is often possible to fix the motor overhead immediately adjacent to the driving pulley; for instance, near the main shaft instead of on the floor, and thus to keep the whole of the floor space available. As smaller-diameter pulleys may be used, faster and therefore cheaper motors may be employed. Loss of power by friction in bearings is reduced too, as the tension is so much smaller than in ordinary drives. This economy sometimes amounts, in practice, to as much as 10 per cent. of the power transmitted. For the same reason, the shafting may be much lighter; the wear and tear is consequently reduced.

An objection sometimes raised is that the frequent reversal of the belt will ruin it, but such destruction does not actually occur; belts have been in use for many years on heavy duty without showing signs of wear. A little consideration will show that the wear of the belt from this cause could not be serious, for the tension at the point of reversal is very small.

All kinds of belt materials may be used with the Lenix system, but the belt must be made continuous and as thin as practicable, the necessary strength being secured by increasing the width rather than the thickness, so that it may be as supple as possible. Leather is to be preferred and the joint may be made as shown in Fig. 6, the ends being well connected together.

The belt should be of such length that the distance *D* equals radius *R*, Fig. 7, thus allowing for a lengthening of the

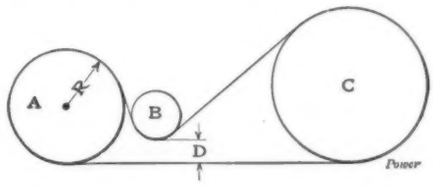


FIG. 7. EFFICIENT ARRANGEMENT OF PULLEYS

belt after starting, the value of *D* when the belt is working being generally about equal to the radius of the Lenix pulley *B*.

Vertical drives are usually unsatisfactory because the initial tension has to be made large owing to the weight of the belt reducing the contact between the belt and the lower pulley; but with the Lenix pulley this is overcome, and vertical drives are equally as satisfactory as others.

The speed ratio obtainable with a single pair of pulleys is limited only by the practicable size of the larger pulley and indeed ratios up to 30 to 1 have been successfully employed.

The slip with the Lenix system is never more than 1 per cent., which is due to the creeping of the belt and is inherent to all systems of belt driving where materials which stretch are employed. When a Lenix drive is stopped, the belt has no strain on it and only has the strain of the effort transmitted while in motion.

Types of Coil for Shop Heating

By H. M. Nicholls.

Very often those who have not made a special study of heating systems are called upon to install them in shops. For their benefit several types of coil, designed to meet various conditions, are presented.

If often happens that people who have never made a study of heating systems are called upon to install heating coils. To such people the following suggestions may be of some use and help them to avoid the annoyance and mistakes so often incurred in such cases.

Fig. 1 shows the design of a wall coil that was recently installed for heating a machine shop. Every square inch of floor space was in use, as was also the wall space all around the shop up to the bottoms of the windows. Therefore the bottom-branch tee was brought down to the bottom of the windows. There are 10 units in all, situated on the north and west walls and the temperature is regulated by adjusting the needle valve in the drip. This gives either live steam or condensation, or both, in the coil, which arrangement makes a very economical proposition. The pressure on the coil is 10 pounds, it being stepped down by a reducing valve from 125 pounds on the service line.

Sketches *A*, *B* and *C*, Fig. 2, show types of circulating coils which are very efficient for factory or shop heating and are made up of 1- or 1¼-inch wrought-iron pipe, screwed into cast-iron branch tees and are hung on the walls just below the windows. Of the various illustrations, *A* is known as a branch coil; *B* is sometimes called a trombone coil and

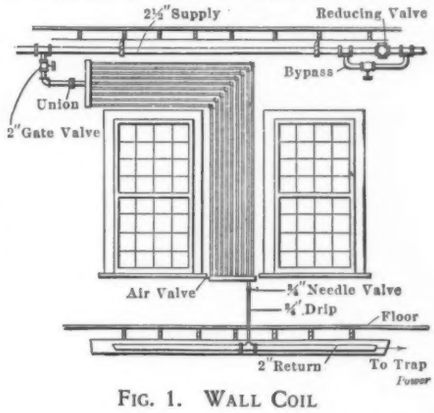


FIG. 1. WALL COIL

is used where the radiation can be placed only on one side of the shop; *C* is called a miter coil and can be used under the

same conditions as *B*, providing there is room for the vertical part. It should be given the preference whenever possible. Coils *D*, *E* and *F* are for hot-water heating and give efficient circulation, which is the most essential qualification of any heating plant. In *D* and *E* the supply pipes may be either drops or risers and in *E* the return may be carried into the steam heating, and the first cost is less. This is a large factor, as any heating system must be designed with radiation capable of heating the building to a habitable temperature in the coldest weather, which involves the expenditure of money for radiating surface that is used only occasionally. In the combination system the necessary requirements

If the system has the horizontal returns below the water line of the boiler, they are known as "wet returns" and a pitch of 1 inch to 40 feet is sufficient, and if sealed may be connected as shown in *B*. But if the returns are above the water line they should be given a pitch of 1 inch to 10 feet. They are then known as "dry returns" and there is

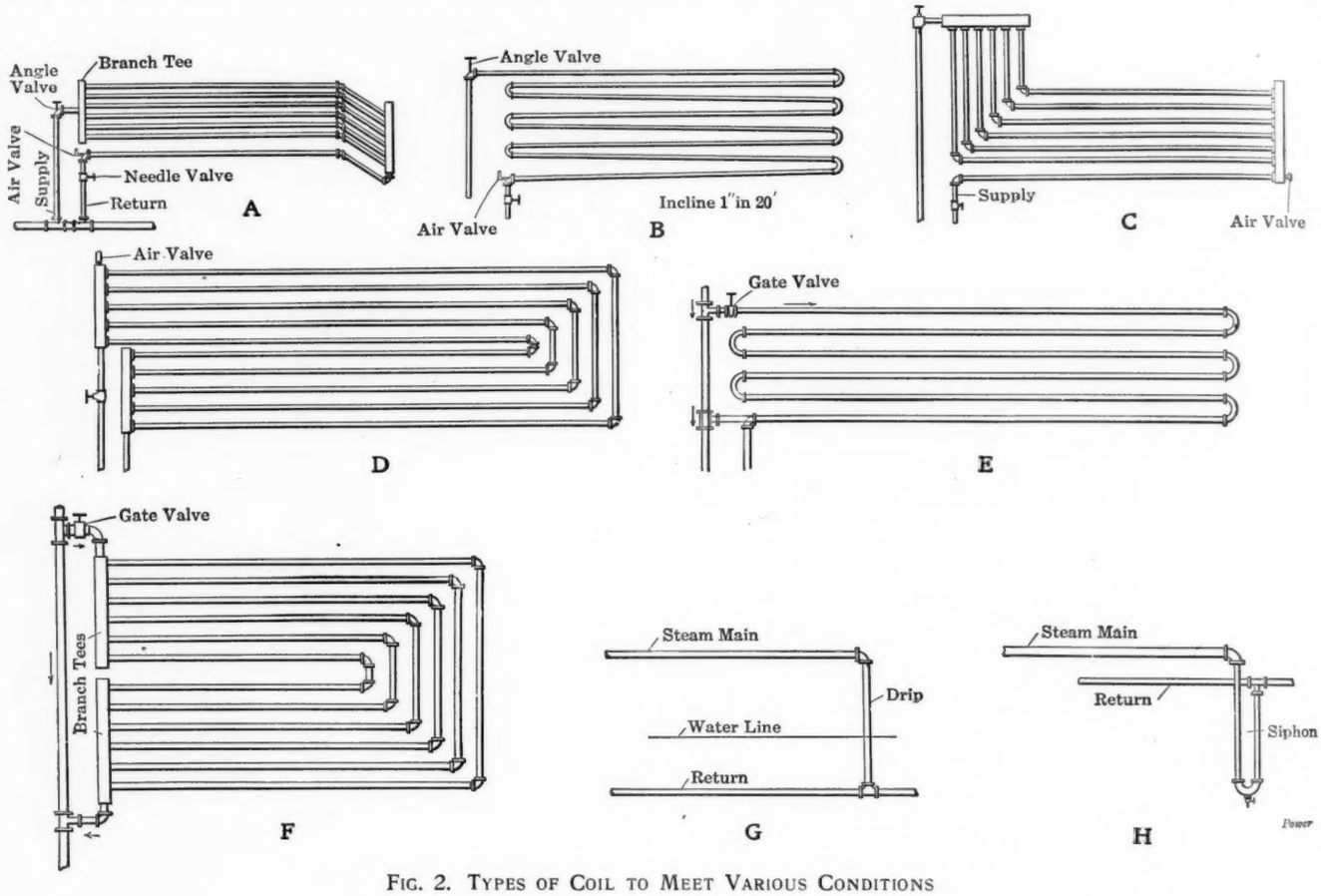


FIG. 2. TYPES OF COIL TO MEET VARIOUS CONDITIONS

supply as indicated by the dotted lines.

A system composed of units such as these, combining the steam and hot-water features, recommends itself for the reason that it secures the advantages of the hot-water heat for moderate temperature and steam heat for extreme cold. There is less radiating surface required for will be met, if the boiler is provided with all fittings required for steam heating, but so arranged that the damper regulator may be closed by means of valves when the system is used for hot water. An expansion tank is also required and must be so arranged that it may be cut out of service when the system is used for steam.

often considerable trouble with water hammer, which, however, may be overcome by the siphon construction shown in *H*. The loop becomes filled with water of condensation and prevents the steam from flowing directly into the return, and as the condensation collects in the loop it overflows into the return and is carried away.

Peculiar Mishap to Corliss Engine

By S. Kirlin

A peculiar accident happened recently in the power house of the Fort Smith Light and Power Company, Fort Smith, Ark. A large piece of the steam chest on the valve-gear side of the low-pressure cylinder of a 1200-horsepower cross-compound Corliss engine blew out, breaking the valve gear of this cylinder and doing considerable damage to the valve gear on the high-pressure cylinder as well.

Parts of the cast-iron section which blew out were hurled to all parts of the engine room, and that more damage or loss of life did not result is remarkable.

The accident is supposed to have been due to some derangement of the valve gear on the low-pressure cylinder which allowed the valves of this cylinder to remain closed, and the steam from the high-pressure cylinder to run the pressure up in the receiver to the bursting strength of the low-pressure steam chest. The receiver was equipped with a relief valve, but whether it failed to operate or if the volume of steam delivered by the high-pressure cylinder was beyond its capacity is not definitely known.

A complete new low-pressure cylinder has been ordered with the latest type of valve gear, and also new valve gear for the high-pressure cylinder. The high-pressure side was quickly repaired and the unit is being operated at reduced load while the new cylinder is being obtained.

Training of Engineers in Europe

By W. H. Dooley

The system of training in vogue a generation ago, being unable to meet the demands of rapidly advancing engineering practice, gave place to the establishment of the modern engineering school. The curricula of several of these schools are given.

Prior to the present generation, the stationary engineer, in Europe, that is, the man who is in charge of and operating a steam, electrical, gas-engine or hydraulic plant, received his training on a small scale from a master engineer, one who held his position by reason of a long experience. This was in the times when there were but few large manufacturing plants. The master engineer took the young man in charge and taught him the craft during a certain number of years, after which the apprentice served under him. This was, as history proves, a good method only so long as the master had time to teach the apprentice. But when the modern era of prosperity was being ushered in and competition became keen, the old engineer was so busy fortifying himself against competitors and keeping up with the technical advancement of his line that time failed him in the instruction of apprentices.

Roughly speaking, the engineers work from 10 to 10½ hours a day. The following schedule will give an idea of the distribution of hours in a manufacturing establishment:

Start, 6:30 a.m.; breakfast, 8:15 to 8:30 a.m.; dinner, 12 to 1:30 p.m.; tea, 4:15 to 4:30 p.m.; shutdown, 6:30 p.m.

On the other hand, the apprentice found that the engineering craft had developed to such an extent and complexity that he could no longer grasp its fundamentals by mere activity in the boiler or engine room.

It was obvious that teaching and learning would have to be done in some other place and at some other time. How could it be better done than in a meeting of all the apprentices with teachers to instruct them; in other words, in a school. As the school meetings could only be held outside of working hours, it was necessary to have evening or Sunday classes. The long working hours (from 6:30 a.m. to 6:30 p.m.) prevented the classes from being held evenings, so they were held on Sunday mornings.

The instruction provided in these classes is made up of two parts: general and technical. The former gives a training in the use of the mother tongue and the rights and duties of citizenship, while the latter takes up subjects closely allied with engineering, such as mechanics, physics, steam and electrical machinery, electrical calculations and the reading of blueprints.

All apprentices are obliged to attend these schools during the period of from 12 to 18 years of age. Employers encourage them to do this by giving them the privilege of attending school during working hours without loss of pay. Nearly 10 hours a week is devoted to this kind of training. The large engineering firms usually donate the equipment to the school, and the teachers are practical men working at their trades.

In addition to these schools there are special schools that the ambitious firemen or assistant engineers may attend. These are scattered and are supported by municipal and state appropriations.

The manufacturers in the leading European cities and notably the German communities have for several years seen in these engineering schools a valuable adjunct, if not an absolute necessity to their business. No one desires to intrust his life and property to one who is not perfectly familiar with the operation of a power plant.

Prior to 1879 the marine service of the German Empire suffered greatly from accidents due to incompetent engineers. These so called engineers came largely from the ranks of the locksmith and firemen and proved to be such poor recruits for the rapidly developing navy and merchant-marine service that the German emperor by a special ordinance prescribed regulations for the holding of examinations for those who desired to become first-class engineers.

The outcome of this was the establishment of two schools for engineers: one at Fleusburg, built in 1886, and one at Stettin, in 1890. At Fleusburg, naval engineers from the fourth to the first grade are educated and at Stettin only those from the fourth to the second grade. The Fleusburg school therefore offers the higher class of instruction.

The work for engineers of the fourth grade, that is, the lowest rank, involves the following studies: German, arithmetic, mechanical engineering, physics and technology, a total of twenty-four hours a week being devoted to these studies for the period of two months. Engineers of the third class study German, arithmetic, mechanical engineering, physics, technology and electrotechnics, a total of thirty hours a week being devoted to these studies for the period of two months. Engineers of the second class study arithmetic, geometry, German, English, mechanical engineering, drawing, mechanics, physics, technology and electrotechnics, a total of forty-five hours a week for a period of five months. The studies of the first class of engineers are German, English, plane geometry, stereometry, arithmetic, trigonometry, mechanics, physics, chemistry, mechanical engineering and drawing, forty-five hours a week for five months being devoted to these branches.

While these periods of study for the various courses are apparently short, much more work is accomplished than the time spent would indicate, the emphasis placed upon previous practical experience of the applicants making it possible to give a large amount of theoretical instruction in a comparatively short time.

One of the leading German schools offering instruction in electrical engineering is situated at Furtwangen, Baden.

The course of study occupies three years. Theoretical instruction is given in the morning and practical instruction in the afternoon. The studies each year and the number of hours devoted to each study during a week are as follows:

First year: arithmetic, four; geometry, stereometry and trigonometry, two; experimental physics, one; geometrical drawing, five; projective and descriptive geometry, four; free-hand drawing, two; German, two; business correspondence, two; business forms, two; total number of hours, twenty-four.

Second year: arithmetic, geometry and stereometry, three; technology and tool study, one; experimental physics, one; mechanics, three; bookkeeping and exchange, one; electrical engineering, three; constructive electrical engineering, six.

Third year: mechanics, one; technology, one; electrical engineering, three; theoretical explanation of constructive work, six.

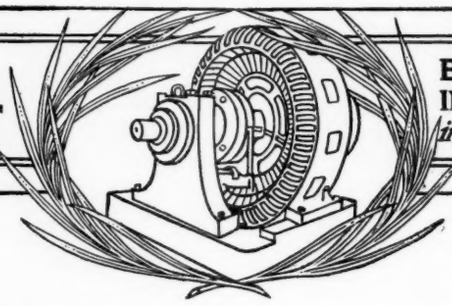
The practical instruction is as follows:

First year: practice in working with files, lathes and drills; practice in hard and soft soldering; making of simple tools, and preparation of materials for work; construction of parts of apparatus employed in electrical engineering and fine mechanics. Thirty-six hours a week are devoted to this work.

Second year: construction of simple electrical apparatus; electric bells, relays, telephones, microphones, induction coils, etc. Thirty-eight hours a week are devoted to this work.

Third year: construction of electrical and magnetic measuring instruments; chronographs, telegraph apparatus, arc lamps, dynamos and electric motors. This work consumes forty-seven hours a week.

ELECTRICAL DEPARTMENT



ESPECIALLY CONDUCTED *to* BE *of* INTEREST *and* SERVICE *to the* MEN *in* CHARGE *of the* ELECTRICAL EQUIPMENT

Primer of Electricity

Losses in Dynamo Armature Cores

In the primer lesson of two weeks ago the energy loss in the armature core of a dynamo due to "eddy" currents was explained. There is another cause of energy loss in an armature which is more important even than eddy currents, because the loss is usually much greater than that due to eddy currents. This is known as "hysteresis" (pronounced hiss-ter-ee-siss, with emphasis on the first and third syllables), which is merely a convenient name for the tendency which all iron and steel have to resist changes in magnetism.

If you connect a coil of wire to a source of electricity, allowing a steady

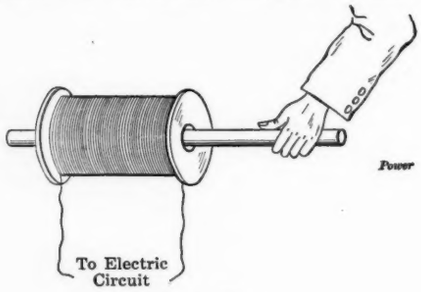


FIG. 49

current to flow through the wire, and then suddenly thrust a bar of iron into the coil, as indicated in Fig. 49, the bar will become magnetized almost instantaneously, and the change in the condition of the particles of iron composing the bar, from nonmagnetic to magnetic, will be resisted by those particles exactly as a big round stone resists your effort to turn it over on the ground, even if you don't lift it.

In the case of the bar, the resistance is a sort of magnetic inertia just as the resistance of the stone is a form of mechanical inertia. There is also some friction effect in both cases, the one magnetic and the other mechanical.

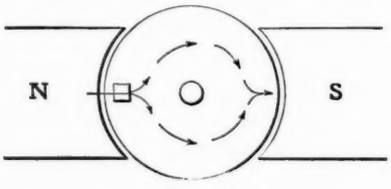


FIG. 50

If, while the bar is in the coil, magnetized by it, the flow of current is cut off, the bar will lose its magnetism, but the particles of iron will resist this change just as they resisted the first one—hysteresis, again. Similarly, after you have turned over a round stone, if you turn it back again to its original position just as much effort will be required as in the first turning, if the ground is smooth and level—inertia, again.

Both of the magnetic and physical processes described will develop heat, because there is nowhere else for the expended energy to go, no mechanical work having been done.

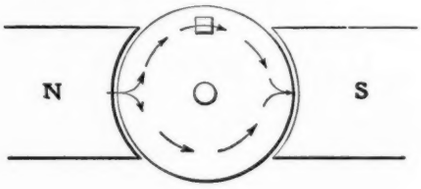


FIG. 51

In a dynamo armature, the magnetic condition of the steel or iron in the core is continuously changing. Referring to Figs. 50, 51 and 52, this will be made clear. When any certain part of the core is under a "north" magnet pole, such as the little portion inclosed in the square in Fig. 50, the magnetization of that portion is in the direction from the edge toward the center of the core, as indicated by the arrow.

When that portion of the core has travelled to a position midway between the poles, the direction of magnetization

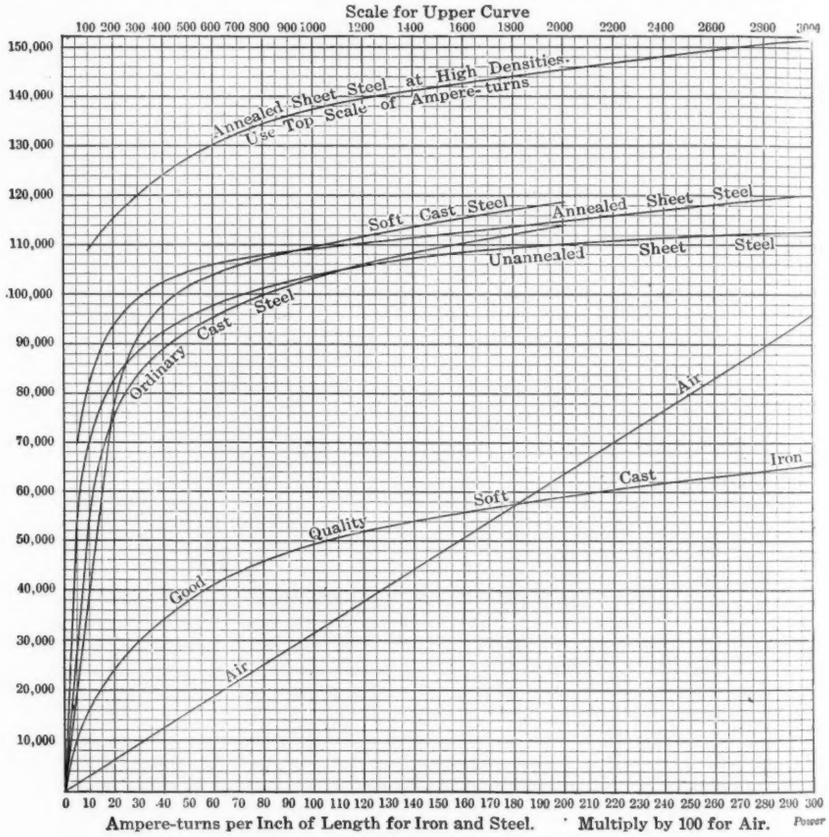


FIG. 53. MAGNETIZATION CURVES FOR STEEL, IRON AND AIR

is from the "north" toward the "south" pole of the magnet, about parallel with the core periphery, as represented in Fig. 51.

When the selected portion of the core reaches a point under the "south" pole

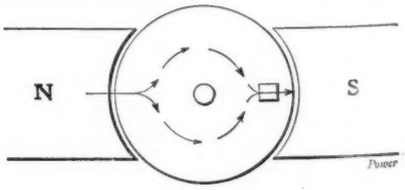


FIG. 52

of the field magnet, the direction of magnetization in it is exactly opposite to what it was when under the "north" pole. See Fig. 52.

From this it is evident that so long as

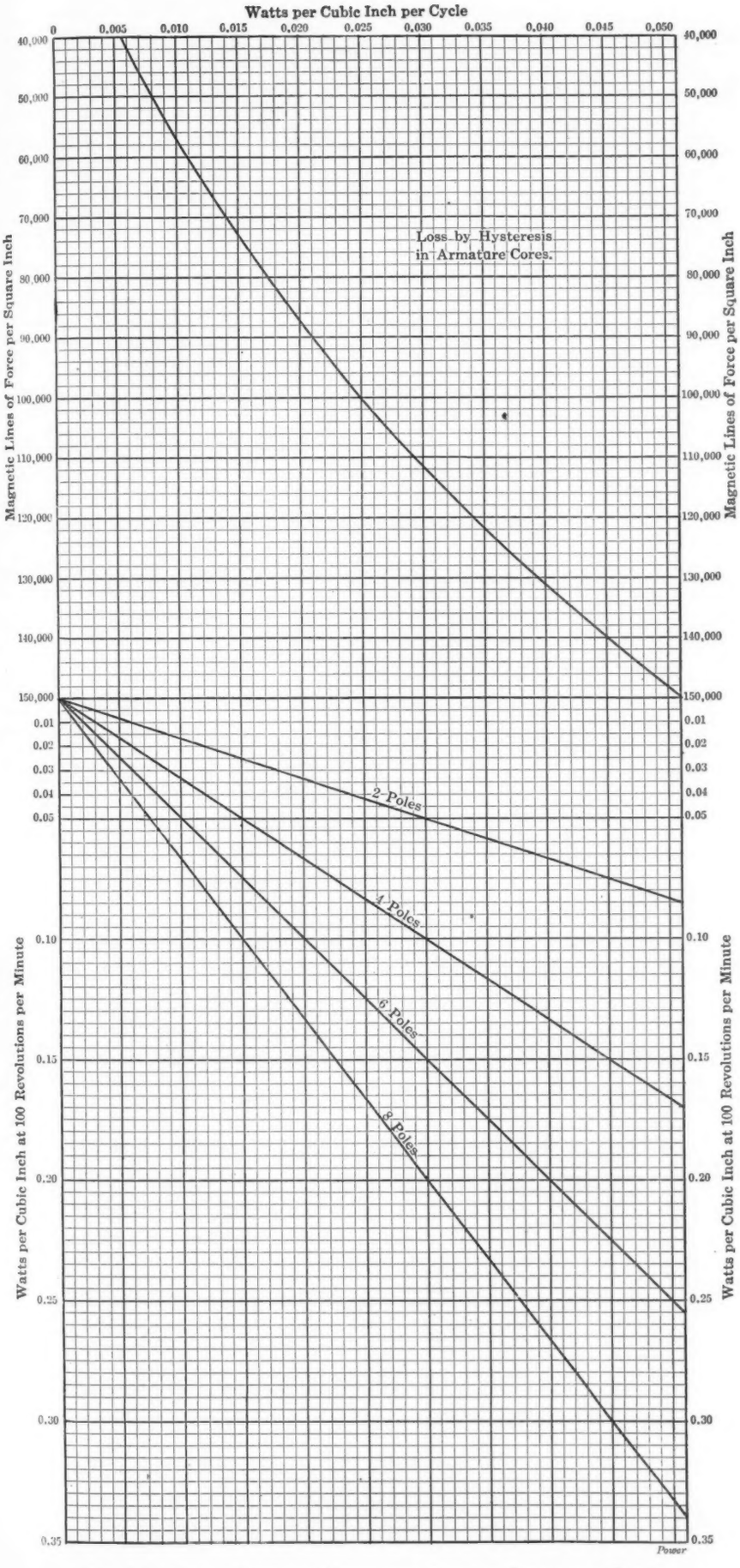


FIG. 54. CHART SHOWING HYSTERESIS LOSS IN ARMATURE CORES

the machine is operating, the direction of magnetization in the core is repeatedly reversed, although the magnetization never ceases, as it did in the case of the bar and coil. This reversal is resisted by the iron particles just as the magnetization and demagnetization of the bar were, but not so strongly because the changes are gradual instead of abrupt. Each time one of these reversals occurs, there is a certain loss due to hysteresis; consequently the loss during each second or minute of operation is greater when there are many reversals per second or minute than when there are few; in fact, the loss is exactly proportional to the number of magnetic reversals per second or minute.

The loss caused by hysteresis at each magnetic reversal is greater when the iron is highly magnetized than when it is feebly magnetized; for the same reason that it takes more effort to roll over a ball of lead than it does to move a ball of wood of the same size. The loss by hysteresis is also directly proportional to the size of the core, of course; if a certain amount of energy is required to overcome the hysteresis of one cubic inch of iron, it will take ten times as much for ten cubic inches.

The hardness of the iron or steel also affects the amount of energy lost by hysteresis each time the magnetization is reversed. This is only what might be expected when you remember that it takes more magnetizing force to get a certain strength, or density, in a piece of hard steel or iron than in a piece of soft steel or iron. If it takes more power to produce a given magnetization, it will naturally take more to reverse that magnetization.

This difference in magnetic quality was fully explained in a lesson on magnetism about three months ago. For the convenience of the present reader, however, Fig. 52 has been prepared to illustrate the differences between the magnetizing forces required by several grades of soft iron and steel commonly used in dynamo construction. The figures of the vertical scale are magnetic densities and those in the horizontal scale are ampere-turns required for each inch of length along the path of the magnetic flux.

Now the number of magnetic reversals per second or minute in a dynamo armature core depends on the number of field-magnet poles and the number of times the core revolves per second or minute under those poles. With two poles, as in Figs. 50 to 52, the magnetization of any one spot in the core is exactly reversed in half a revolution, and reversed again, back to the starting condition, during the second half of the revolution. This double reversal, from one condition to the exact opposite and back again, is called one "cycle", and the

number of "cycles" per second is called the "frequency" of the changes in magnetic condition.

Fig. 54 shows the watts usually lost by hysteresis in each cubic inch of an armature core of the usual quality of steel at different magnetic densities and "frequencies." The lower part of the chart is convenient for applying the upper part to different numbers of magnet poles and rates of speed. It merely translates the frequency in cycles per second to revolutions per minute and number of magnet poles.

Suppose, for example, that it is desired to estimate the loss by hysteresis in the 24-inch armature core mentioned in the last lesson. This was 10 inches long, gross measurement, or 9 inches actual steel, and had a 12-inch hole in the center, making 3054 cubic inches of metal.

Suppose the density in the core was 70,000 lines per square inch and it ran at 600 revolutions per minute in a four-pole field. Starting at 70,000 in the scale of magnetic densities, trace horizontally along that line until you reach the curve; then trace straight down until you strike the diagonal line marked "4 Poles." From this point trace horizontally to the scale at either edge of the chart and you will land at a point corresponding to 0.04667 in the scale.

This means that 0.04667 of one watt will be lost by hysteresis in each cubic inch of the core, for each one hundred revolutions per minute. As there are 600 revolutions per minute and 3054 cubic inches of steel in the core, the loss will be

$$6 \times 3054 \times 0.04667 = 855$$

watts, just as long as the armature continues to run, unless the speed or the density should change.

Combination Steam or Gas Engine Driven Generator

By S. Kirlin

An electric-light plant originally consisted of two boilers and two high-speed engines, each engine being belted to a 100-kilowatt generator. Later it was decided to operate the plant with gas engines, holding the steam plant in reserve. As the supply of gas was not absolutely reliable, the engineer in charge of the plant decided to arrange matters so that either of the generators could be quickly changed to the steam engines, in case of a failure in the gas supply, or an accident to either of the gas engines. This was done by the arrangement shown in Fig. 1.

Two light rails were run the full length of the room, being laid in a concrete foundation, with the tops above the level of the engine-room floor, and each generator being mounted on iron ways lagged to the wood base, and having their ends bent to fit over the rails as shown at *A, A,* Figs. 1 and 2.

The mains to each of the generators were run in a conduit under the floor, being tapped with flexible leads as shown, to enable them to be quickly connected with the generator in either position.

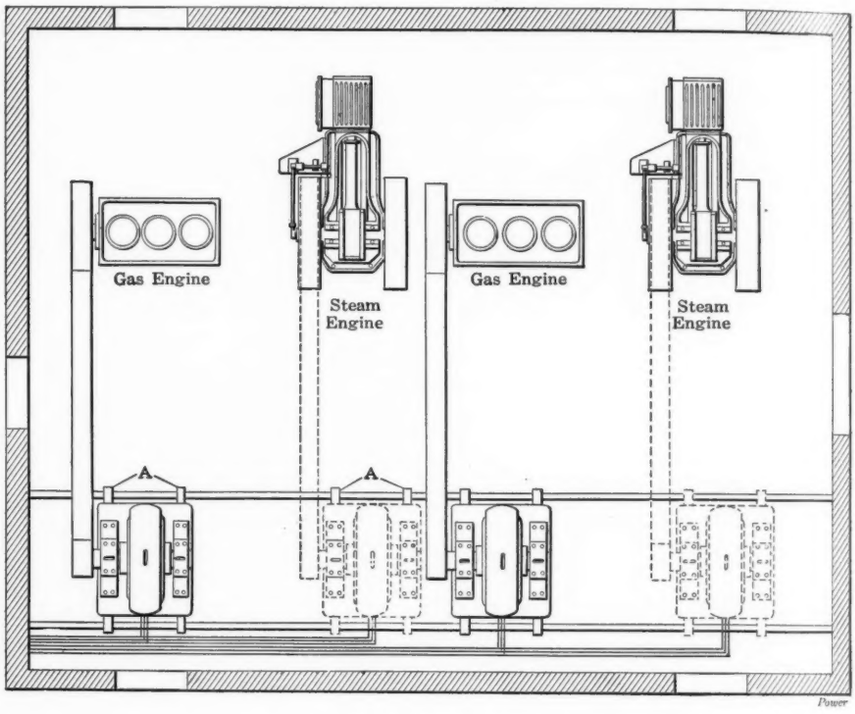


Fig. 1. Plan View of Station

The proper position to bring the generator in line with the driving pulley of either engine was marked on the rails, and by means of a block and tackle one man could easily shift the generators from one position to the other in a few minutes.

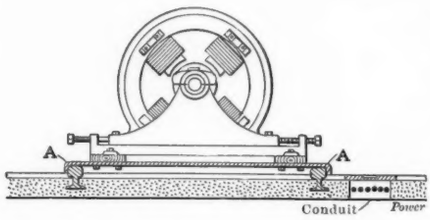


Fig. 2. Design of Generator Base

We hear that the Swiss State Railway authorities are engaged in securing water power all over the country for the purpose of electric-power supply for the railways. The power secured in Canton Tessin now amounts to 30,000 horsepower, and in Canton Uri to 17,000 horsepower. The total amount already taken is about 70,000 horsepower, and still more is required.

Correspondence

Sparking at Direct Current Commutator Brushes

A bipolar direct-current dynamo of 15 kilowatts capacity, equipped with carbon brushes, sparked persistently and defied the efforts of three experienced dynamo runners to stop it. Finally, in turning the armature over slowly by hand while inspecting the commutator leads for a broken connection or other trouble, I happened to notice that one of the armature coils looked black, as though it had been scorched. Tracing the leads from that coil to the commutator, I found that the "leading" bar to which this coil was connected was much hotter than the neighboring commutator bars. Further investigation brought out the fact that the wire in this coil was considerably shorter than the others in the winding. From these "discoveries" I was convinced that when the coil was in good condition its lower resistance caused it to take a heavier current, during the moments when it was short-circuited by the brushes for commutation, than the other coils took, and this had overheated it sufficiently to cause the insulation to gradually char; the natural result was a partial short-circuit of the coil, producing sparking and still further overheating. After a new coil was put in in the place of the charred one, the machine worked as smoothly as when new.

When a machine sparks at the brushes and no loose connections, grounds, short-circuits or open circuits can be found, it is sometimes possible to stop the spark-

ing by merely shifting the brushes, and this should always be tried the first thing, before spending any time testing or hunting for other troubles. If the brush holders are not of the straight radial type, it may be that the brushes on one stud are not touching the commutator at the proper distance from those on the other studs; but this will usually be indicated by the sparking being restricted to the one set of brushes that is out of place. Many old machines, however, require the brush rocker arm to be shifted whenever the load changes much, and these machines will spark viciously if the rocker arm is not adjusted for the load that is being carried at the moment.

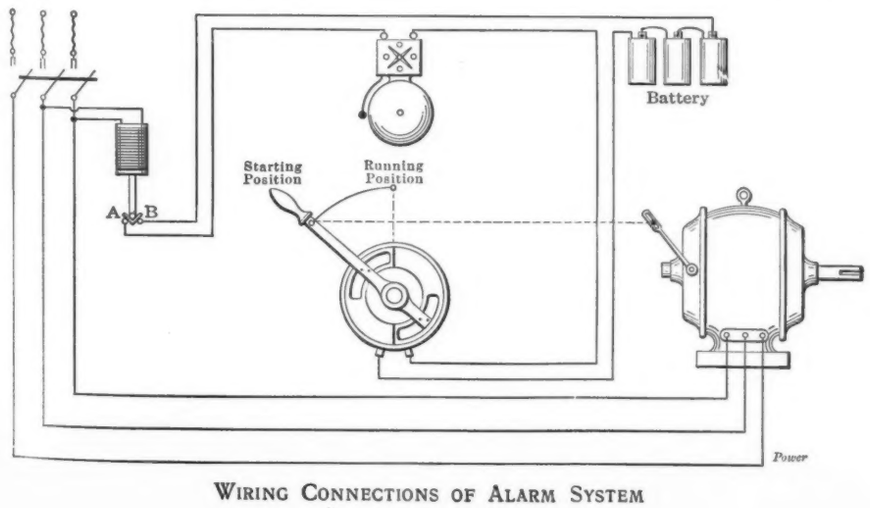
R. A. CULTRA.

Boston, Mass.

An Alarm against Wrong Motor Starting

There are many induction motors in use at the present time with the starting resistance mounted on the rotor spider. These motors are started by first closing the line switch and then cutting out the starting resistance by means of a handle attached to the motor frame. When the motor is stopped this handle should be returned to the starting position before the line switch is again closed. Careless operators often forget this detail and severe shock to the motor and shafting results when the line switch is closed.

The accompanying diagram shows an alarm devised by the writer to prevent this forgetfulness on the part of the motor operatives. A small solenoid with a laminated core is connected across one phase of the motor leads between the motor and its main switch. The plunger of this solenoid drops and bridges the contacts *A* and *B* as soon as the current supply to the motor is interrupted. The starting handle on the motor is fitted with a pair of brushes which connect a pair of stationary contact plates when the handle is in the running position and open the circuit when in the starting position. These contacts are in series with the solenoid contacts and a bell and dry battery. As soon as the operator opens the main switch the solenoid closes the contacts *A*, *B*, and current from battery passes through the contacts on the starting handle to the alarm bell, which rings continuously, of course, until the operator opens the bell circuit by returning the handle to the starting position. If an attempt were made to set the starting handle at the running position while the main switch was open, the alarm bell would give immediate warning. This simple device practically eliminates all trouble due to thoughtless operators, especially if the running down of the battery be guarded against by the substitution of one of the many forms of bell-ringing transformers on the market.



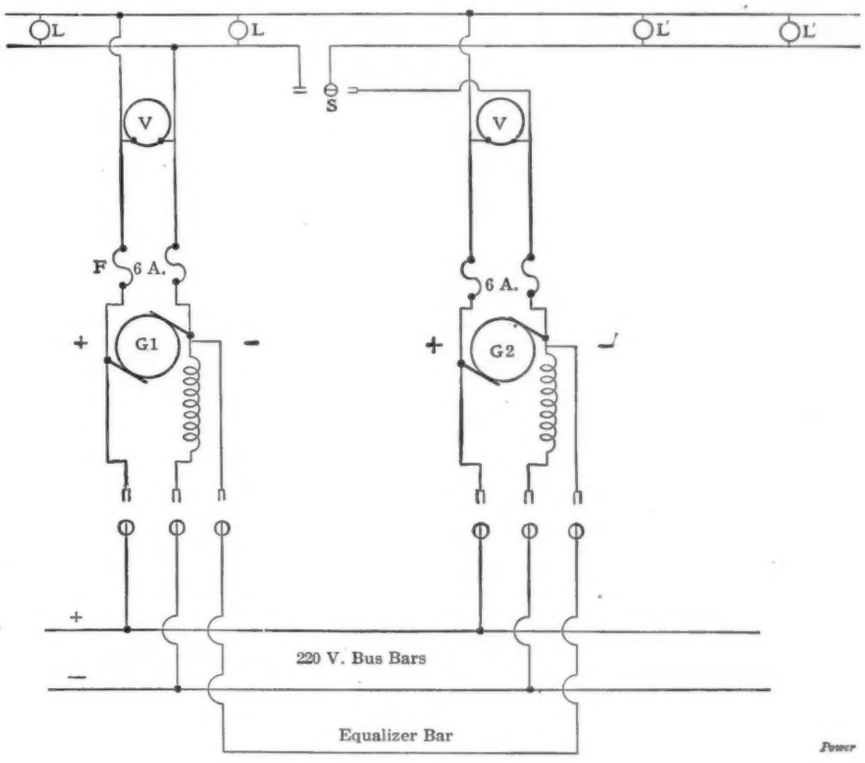
WIRING CONNECTIONS OF ALARM SYSTEM

R. H. FENKHAUSEN.

San Francisco, Cal.

Why Do the Fuses Blow?

The accompanying diagram shows switchboard connections which failed to operate as we expected. A 150-kilowatt 220-volt generator *G*1 was direct connected to a high-speed engine, and a 125-kilowatt 220-volt generator *G*2 was belted to a Corliss engine. Both machines were compound wound and ran in parallel, when necessary. The switchboard lamps *L* are on a generator panel, and the lamps *L'* are on another panel.



WHY DO THE FUSES BLOW?

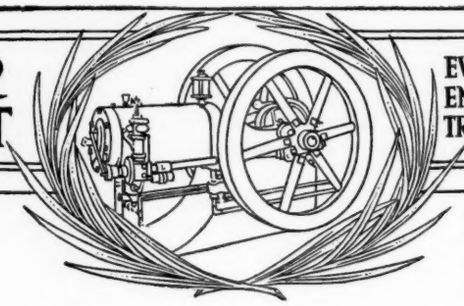
The double-throw switch *S* was put in to connect the lamps *L'* either to the generator *G*1 (when in the left-hand position) or to *G*2 (when in the right-hand position). All worked well until the first time the generator *G*2 was cut in on the busbars while *G*1 was running, which resulted in blowing the fuse *F*. Every time *G*2 was cut in while *G*1 was in operation this fuse would blow, but *G*1 could be cut in while *G*2 was in operation without trouble. Will someone kindly suggest an explanation?

It is not necessary to run the lamps in the way shown; in fact they have already been changed, but I would like to know what caused the trouble.

E. L. CARLTON.

Jamestown, N. D.

GAS POWER DEPARTMENT



EVERY THING WORTH WHILE *in the* GAS ENGINE *and* PRODUCER INDUSTRY WILL BE TREATED HERE *for the* USE *of* PRACTICAL MEN

The Inherent Difficulty of the Gas Turbine

By R. C. H. Heck*

This title, although rather long as it stands, needs several words more to make its meaning clear and definite. The difficulty referred to is a fundamental reason why the gas turbine (and its prototype in the piston-engine field, the gas engine with combustion at constant pressure) has been so slow of successful realization. This reason goes deeper than troubles in the line of construction, due to the need of finding materials for nozzles and vanes that will withstand very high temperatures; these requirements are serious enough, but they have been or can be met or obviated. The difficulty in the way of a practically successful gas turbine is a matter of underlying simple theory, and it can best be made clear if we first consider some facts in regard to the piston or static-pressure engine.

The operation of ideal efficiency is represented by Fig. 1, which is the pressure-volume diagram for the Carnot cycle. (See also the temperature-entropy diagram in Fig. 3.) The parts or phases of this operation are, first, isothermal expansion *A-B*, with the reception of heat and increase of entropy; second, adiabatic expansion *B-C*, at constant entropy, because no heat passes to or from the medium, but with a drop of temperature; third, isothermal compression *C-D*, with rejection of heat and decrease of entropy, and fourth, adiabatic compression *D-A*, with rise of temperature, closing the cycle by bringing the medium back to its initial state at *A*.

In a temperature-entropy diagram the particular properties of the medium or working substance do not appear; if this medium or working substance is put through the series of alternate isothermal and adiabatic operations described, the ideal efficiency in heat conversion will be realized. But when we come to the actual engine and begin to look at the mechanical side of its performance, the properties of the medium assume first importance. This fact is illustrated in Figs. 1 and 2, which are pressure-volume diagrams, drawn in true proportions, for air and for steam respectively.

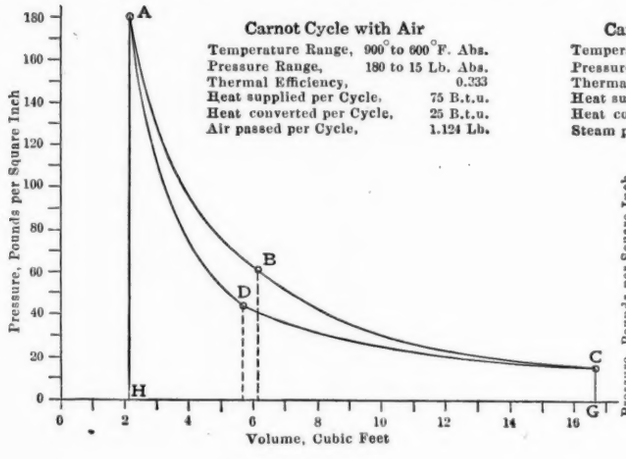


FIG. 1

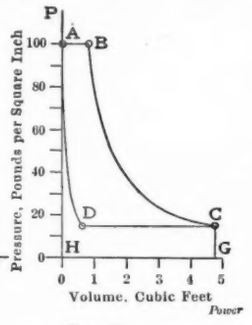


FIG. 2

To make the comparison definite, the numerical values are stated on the diagrams. As a basis of comparison, the two diagrams are drawn for the same work output per cycle, the areas *A-B-C-D-A* being equal, and the scales of pressure and volume are the same in both diagrams. For further comparison, the two entropy-temperature diagrams corresponding to Figs. 1 and 2 are drawn together in Fig. 3. With the governing values here assumed, the air engine has a decided thermal advantage over the steam engine, as appears in Fig. 3; but when we come to the question as to how the two cases work out in the actual machines, the advantage is even more strongly on the side of the steam cycle.

From the mechanical viewpoint the operation of an engine is divided into two main parts; these are the outward or work-performing stroke of the piston and the return or work-absorbing stroke. The desirable condition is to have a high pressure during the working stroke and a low resistance during the return stroke, with the mean effective pressure bearing a good ratio to the total range of pressure. In Fig. 1, the mean pressure under the curve *A-B-C* is high, or the work area *H-A-B-C-G-H* is large; but so is also the area *G-C-D-A-H-G* or the mean pressure under *C-D-A*. With these big pressures in both strokes there is but a small mean effective pressure, with a small net performance of work per unit of piston displacement. In Fig. 2, on the other hand, the negative work *G-C-D-A-H-G* is small, the effective pressure is relatively high, and with this larger pressure goes a smaller displacement volume.

To embody the action represented by Fig. 1 would require a big machine because of the vertical narrowness of the closed diagram *A-B-C-D-A*, and a very strong and heavy machine because the maximum pressure runs so high (at the point *A*). The more compact diagram in Fig. 2 is a far more useful form. The great drawback of the operation represented by Fig. 1 is that so much of the work done by the air upon the piston in the forward stroke has to be given back to the air in order to bring it up to the starting point *A* that only a little is left over for useful application.

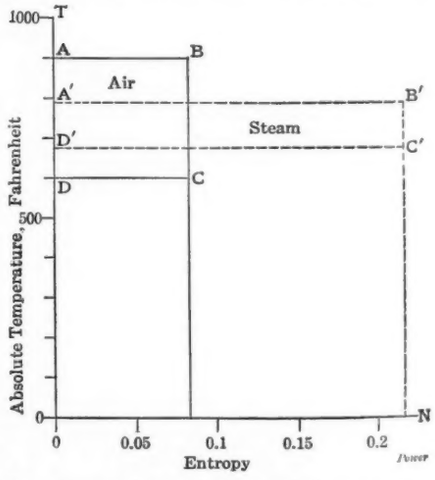


FIG. 3. COMPARATIVE TEMPERATURE-ENTROPY DIAGRAMS

It must be acknowledged that in the ideal cases thus far considered, with neither secondary thermal losses nor frictional losses in the machine, this question of work distribution is chiefly one of convenience. But we have been

*Professor of mechanical engineering, Rutgers College, New Brunswick, N. J.

working toward, and can now consider, the actual machine in which both kinds of losses are active. As the negative or compressive work takes up a larger proportion of the total work of the out stroke, leaving less as available for output, the secondary losses will encroach more and more upon the balance, rapidly cutting the efficiency down from its ideal value. If two engines were "built around" the diagrams in Figs. 1 and 2, it is probable that the frictional losses in mosphere is always on the other side of a single-acting piston) need be done by the machine on the gas; and while the piston is moving slowly or is practically stationary at the end of the compression stroke, the pressure is raised from *D* to *A* by the combustion of gases at constant volume, without further expenditure of work. The compressive work under the curve *C-D* is relatively much greater than in a steam engine, but is not big enough for its entailed losses to have work, defined by the ratio of *G-D-A-E-O-G* to *O-E-B-C-G-O*, lies the great difficulty to be met in making this an effective engine. The scheme is mechanically ineffective because the big separate amounts of work in the operations of expansion and compression determine the losses, while the small net thermodynamic output has to suffer these losses.

Coming now to the turbine, the application of the criterion of "mechanical effectiveness" will take a good deal less

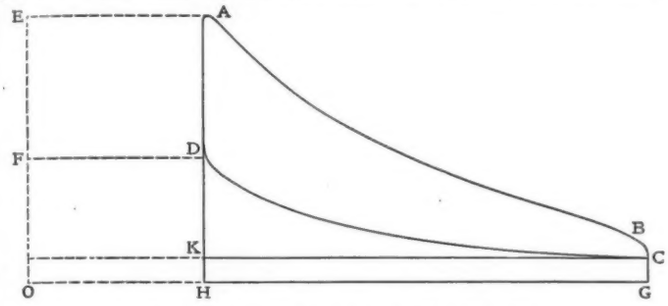


FIG. 4. CONSTANT-VOLUME COMBUSTION

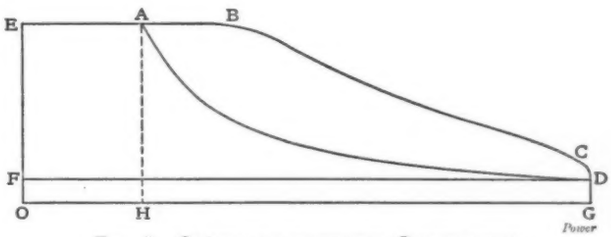


FIG. 5. CONSTANT-PRESSURE COMBUSTION

the first one would alone be almost enough to bring its net efficiency down to that of the second engine.

The ideas which we have been developing can best be summed up in the term *mechanical effectiveness*. Fig. 1 represents an operation of high thermodynamic efficiency but one which would require an unwieldy machine and would have its relatively small net work output nearly wiped out by unavoidable losses. The function of the return stroke or of the compressive action in any engine is to bring the medium to or well toward the condition of high pressure which it must have at the beginning of the working stroke. As the proportion of work (not heat) required for this operation increases, the thermodynamic scheme becomes less and less effective for use in an actual plant.

much effect upon the higher thermal efficiency which results from the great temperature range.

Fig. 5 shows the performance of a gas engine operated with combustion at constant pressure. At first sight one compares the outline *A-B-C-D-A* here with the corresponding outline in Fig. 4, and notes a considerable narrowing of this effective diagram area, although not enough to put it out of the field of usefulness. But now arises the necessity of entirely separating the compressive and the expansive operations, putting them into different cylinders. The compressor must then do the whole work *G-D-A-E-O-G* (or *D-A-E-F-D*), not only raising the charge of gas and air, or perhaps of air alone, to the high pressure at *A*, but also delivering this charge into the reservoir against the pressure *O-E*.

space than the development of that criterion has required. The diagram shown in Fig. 6, which is really two diagrams on the same base, represents the performance of the steam turbine and illustrates conditions of high effectiveness. The energy available for the steam jet is represented by the shaded area *A-B-C-D-A;* it is the same in amount as the work developed in the forward stroke of an engine piston. From the Carnot cycle in Fig. 2 is dropped the adiabatic compression *D-A;* instead, the steam is completely condensed and the equivalent amount of water is put into the boiler by the feed pump. The work of the feed pump is shown in much exaggerated proportions by the area *A-D-E-F-A;* if drawn to true scale this rectangle would not be distinguishable from the line *A-D*, and the work which it

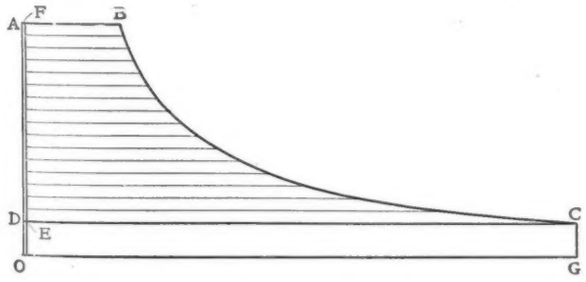


FIG. 6. STEAM TURBINE WORK DIAGRAM

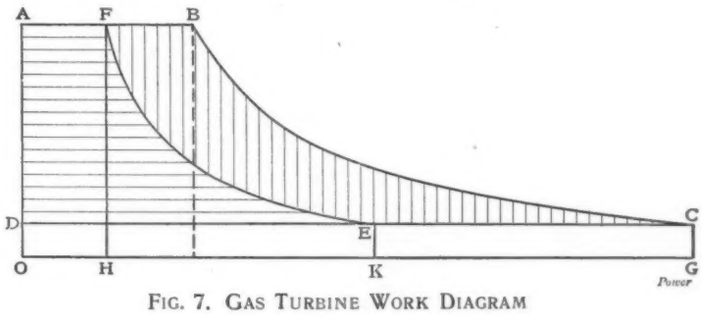


FIG. 7. GAS TURBINE WORK DIAGRAM

To illustrate the statement just made, another comparison is set forth in Figs. 4 and 5. The first is the diagram of the ordinary gas engine, with only the main outline *A-B-C-D-A* shown; it represents equally well the four-stroke and the two-stroke cycles, since the manner of expelling the waste gases and taking in a fresh charge is here immaterial. The point to be emphasized is that only the work *G-C-D-H-G* (usually only *C-D-K-C*, since the pressure of the at-

In taking its charge, of volume *E-A*, from the reservoir, the engine receives back the work done by the compressor, minus losses due to flow and cooling, and the combustion increases the volume to *E-B*. If now the engine fails of ideal efficiency by even a moderate amount and if the compressor has only a moderately good efficiency in the performance of its work, the amount deducted from the narrow output diagram may be excessive. In the high proportion of compressive

represents is an almost negligible quantity. In good working the steam turbine will deliver from 60 to 70 per cent. of the theoretically available energy of the steam.

The corresponding diagram for the gas-turbine plant is shown in Fig. 7. The total shaded area *A-B-C-D-A* represents the total work that the turbine itself can possibly get out of the gas. Actually, the gas turbine is likely to realize a less proportion of its ideal efficiency than the

steam turbine, certainly not a greater. The area *E-F-A-D-E*, shaded horizontally, represents the work output of the compressor, and the work it absorbs will exceed this by an amount depending on the compressor efficiency. The net area *F-B-C-E-F*, shaded vertically, represents the total work ideally available for output by the whole plant, or by turbine and compressor combined. As the turbine and compressor drop off in efficiency, the system falls toward a condition of equilibrium within itself, plenty of work being handled but very little of it delivered as effective output.

If it were possible to deliver both fuel and oxygen in a concentrated liquid or solid form, the gas turbine would at once leap into a commanding position. The use of a liquid fuel is a help, but only to a small degree, since the volume of the fuel as gas is only about one-fifth to one-eighth of the air volume. The whole trouble lies in the unmanageable bulk of the air that must be raised to high pressure before it can be fed into the combustion chamber of the turbine. The gas turbine is by no means an impossibility, but it is under a tremendous handicap as compared with the more readily effective types of heat engines.

In connection with the performance represented by Fig. 5, it is pertinent to remark that the Diesel engine, while it compresses the charge of air nearly to the highest pressure of the working stroke, does this within the working cylinder. Its compressive work corresponds to the area *K-E-F-H-K* but does not include the work of expulsion *H-F-A-O-H*.

Taking Care of a Gas Engine

By W. R. Willard

Your body must receive proper food, proper rest, proper cleansing and be kept at the proper temperature if you wish to get good work from it; and in case of accident or sickness you must set to work immediately to repair the damage or remove the cause of complaint. Just so it is with a gas or gasolene engine. If an engine is expected to give good work it must receive proper attention.

An engineer who allows a hole in his coat or overalls to go unmended unnecessarily is the one that will be most likely to neglect a leaking gasolene pipe and come to work the next morning to find the building he left the night before scattered all over the neighborhood.

"Time is money" is a familiar maxim to most engineers, but if they familiarized themselves with the equally true maxim: "Care is character," they would find that carefulness is worth more than time. Every engine should be kept clean, inside and out. Kerosene is to a gas or oil engine what soap is to the body, and more. It not only removes the dirt from the outside but it cleans the inside as well. At least once a week a small cupful of kerosene should be put in each cylinder in such a way that it will flow through the valves and into the cylinder. Then the engine should be turned over a few times to allow the oil to touch every part. It can then be drawn off through the cocks. If carbon is allowed to accumulate on the walls of the cylinder very long, it will get ground into the iron and no amount of kerosene will remove it. When the walls once become scratched or roughened from such deposits the gas will leak past the piston and poor compression will result. After the kerosene has all been drained off and the cocks closed, a little cylinder oil may be put in, in the same way the kerosene was, and the engine turned over again. Then wash the spark plugs thoroughly with gasolene and replace them.

Cooling the Cylinders

There are two methods of keeping cylinders cool: by means of air and water. Air cooling, however, has many disadvantages. If it were possible to make a perfect cylinder, inside and out, and to obtain equal expansion in all parts, air cooling would be all well and good. I have known the blowing of a blast of cold air against one side of a cylinder to warp it out of shape to such an extent that the piston could not be moved at all. When air-cooled engines are worked hard they almost always lose their shape and cause excessive friction on the piston.

How cool should cylinders be kept? Some say that the temperature should never go above 150 degrees, and the cooler the better. We all know that gas and gasolene engines work on the principle of the expansion of gases which have been heated by combustion. A greater weight of gas can be drawn into a cold cylinder by each stroke than into a hot one and when that gas is burned the pressure rise will be greater. But, while the quantity of gas drawn into the cold cylinder will produce more heat, much more of the heat is wasted in warming the jacket water, and the compression pressure of this gas will not be as great as it would if the walls were hotter. Those who have followed the improvements of the engine from its infancy will remember that in the days of low compression it took almost 100 cubic feet of gas an hour to produce one horsepower, but since the use of high compression the economy has been greatly increased. Then again, heat means power and the more of it the jacket water carries away the more power we lose.

A careful boiler tender always takes the precaution of using soft water or a good boiler compound in the water to prevent scale formation on the tubes; he also sees that the tubes are always clean. Now, the condition of the water jacket has an important effect on the life and economy of the engine. If hard water, without any softening compound, is used the whole system should be washed out once a week or so with a strong solution of soda. After the solution has been drawn off the jacket should be flushed out with fresh water.

Lubrication

Lubricating a gas-engine cylinder is a much different problem from that of lubricating an ordinary bearing. In the first place, there is the question of high temperatures to contend with; in the second place, the oil must contain as little free carbon as possible. Moreover, at each explosion the oil is all burnt off and a new supply must be introduced, whereas in an ordinary bearing it remains in contact some time. The better the oil the better the engine will run; it never pays to use a poor oil. Then again, it is much better to use five drops too much oil than one drop too little. A few drops placed where oil is needed will do more good than gallons of it will in the store room.

Starting

It is sometimes hard to start an engine, especially after it has been standing some time. This may be due to poor compression, caused by all the oil having run out while the engine was standing. In such a case a mixture of lubricating oil and kerosene, introduced in the cylinder through the spark-plug hole, will usually "tighten up" the compression enough to enable the engine to start promptly. If it is necessary to add water in the jacket, it is advisable to use hot water, because a better mixture of gas and air will be obtained. This is especially true in cold weather.

Ignition

If the igniter sparks all right but the engine will not run, there can be only two things at fault. Either the mixture is very poor or the spark is not strong enough to explode the gas. If it is a jump-spark system the points of the spark plug should not be more than 1/32 inch apart. Often the battery will be strong enough to make a good spark in air but when the plug is in the cylinder the spark will not be "hot" enough, or perhaps the voltage will not be strong enough to jump at all. Dry batteries should be tested after a run to get a proper estimate of their condition; if left standing a few hours a battery that was almost exhausted will show fairly good voltage, but after the circuit has been closed only once or twice, it will weaken so much that no spark can be obtained at the plug points when in the cylinder and subjected to the compression pressure.

FROM READERS *with* SOMETHING TO SAY

PRACTICAL INFORMATION *from the* MAN *on the* JOB: A LETTER GOOD ENOUGH *to* PRINT *is* GOOD ENOUGH *to* PAY *for*

Perpetual Motion

Ever since the days of Adam there have been numerous attempts made to beat old Mother Nature at her own game and invent perpetual motion. History does not record the fact, but it would be safe to bet that at some time in his life, when Eve did not have him busy beating carpets, chopping wood, or doing some other kind of work that a man's wife is supposed to do, that old Adam himself sneaked out behind the barn and took a whirl at the perpetual-motion game; and he probably came just as near to solving it as any of his descendants have at any time since.

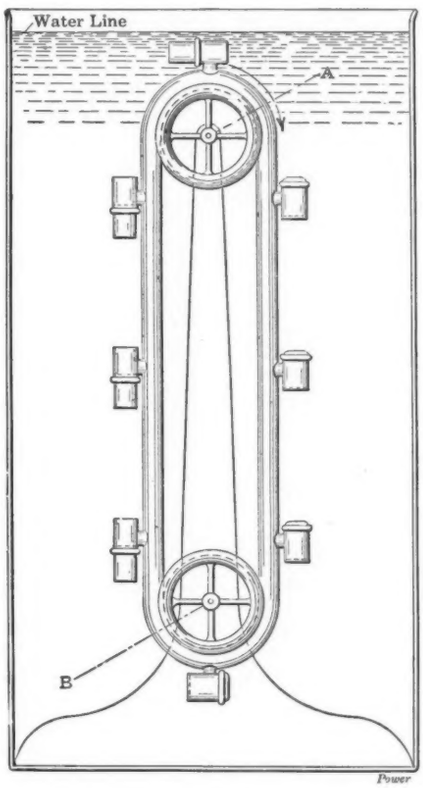
In almost all devices of this kind where the power is supposed to be obtained by the means of sliding weights, levers, etc., the reason for their failure to work is usually easily seen. The real reason for one failing to work when constructed to operate by the buoyancy effect of water displaced, is not just as easily explained as one might at first think.

In the sketch shown, two grooved pulleys are attached to the standard and carry the rubber tube, at equal points on which are attached the cylinders which contain heavy plungers; these plungers slide in and out of the cylinders as they pass the top and bottom centers, the plungers being heavy enough to slide out by their own weight at the bottom against the pressure of the water.

The connections from the tube to the cylinders allow the air to pass freely from one of the cylinders to the other when the plungers are sliding into one and out of the other. The air in the tube is supposed to be at atmospheric pressure at all times, and the tube to be stiff enough to withstand the water pressure without collapsing.

As shown in the sketch, the three cylinders on the left-hand side which are going up are open, while the three on the opposite side which are going down are closed. The other two are passing the centers, and as all of the cylinders are of the same weight, it will be seen that as there are always an equal number on each side the weight is practically balanced at all times, and during a portion of the time there will be four on one side open, and a like number on the other side closed; the plunger of the cylinder that is passing the top center will close about when it has reached the point shown by the dotted line *A*, and the one passing the bottom center will open when it has reached the point as shown by line *B*.

Now supposing that each of the cylinders when closed has a displacement of five pounds of water, and when open has a displacement of nine pounds, this will make a total displacement of the three going down equal to 15 pounds, while the total displacement of the three going up on the opposite side will be 27 pounds. As the two which are passing the centers are practically balanced, there will be a buoyancy equivalent to 12 pounds in favor of the ones which



PERPETUAL MOTION—PERHAPS

are open and going up; this should keep things moving, and the question is will it do so, and if not why not?

In figuring on this the following facts should be remembered: That the air pressure in the tube and cylinders is supposed to be the same at all times, and merely serves the purpose of allowing the cylinders to be filled and emptied without resistance. That the plungers are heavy enough to slide out at the bottom by their own weight against the water pressure, and are practically frictionless and water tight.

Instead of the cylinders being carried directly on the tube, they might be attached to a chain running over sprocket wheels and a small air tube carried around and attached to all of the cylinders for allowing the air to be passed from the one passing the top to the one passing the bottom. The sketch herewith shown, however, will illustrate the principle, and would probably work as good as any other construction.

On account of the present high cost of living, the writer has not taken out a patent on this, so if any of the readers of POWER wish to build one to operate their plants with there will be no danger of infringement, and they are at liberty to do so.

In giving an opinion on this, do not simply say that it "will not work," and let it go at that, but go ahead and say just why it will not work.

S. KIRLIN.

New York, N. Y.

Some Causes of a Pound

What is more misleading than a pound in an engine, and how many of us have been deceived as to its location?

I once had an engine that had developed a very disagreeable pound which seemed to vibrate to every part and to be as much in one place as another. After completely dismantling the engine, which was of a riding-cutoff type, I was about to give up in despair when the idea occurred to me that the piston rod was loose in the crosshead. This had a tapered key and upon striking the key it went down about ¼ inch and the pound ceased.

Another engine would not stop pounding unless the piston was turned around to a certain position in the cylinder, and having unequal clearance it was at first thought that the piston was riding on a shoulder. But such was not the case, as I had previously added shims in the end of the connecting rod, which had the strap-gib and key style of end, and would have lengthened the connecting rod, driving it off a shoulder toward the head end. There was no change in the pound unless the piston was given a slight turn. The secret of this was that the piston and cylinder had worn egg shape and the change made a new and closer fitting bearing surface.

I recall the case of a high-speed engine with shaft governor, which chattered badly at light load and high pressure. This proved to be due to the valve travel being too short, practically centralizing

over the ports and causing the exhaust ports to be closed nearly all the time. This resulted in the compression being higher than the boiler pressure, and at times causing the valve to lift and relieve itself; its return to the seat caused the pound. This was remedied by lowering the boiler pressure, thus automatically lengthening the cutoff, keeping the exhaust port open longer and decreasing the compression.

A. C. WALDRON.

West Lynn, Mass.

Trouble with a Water Column

We have two return-tubular boilers, 66 inches in diameter by 18 feet in length, with 54 four-inch tubes, fitted with pop safety valves set to blow at 120 pounds. These boilers are fed by a double-plunger Deane pump. The feed-water line to the boilers is 2 inches in diameter, and is carried across the boiler fronts just above the fire doors, then to each boiler through a 1½-inch riser, fitted with a ball check and two globe valves, one above and the other below the check. The feed pipe enters the boiler through the front flue sheet above the flues, then back to within about 2 feet of the back head, and is there clamped to one of the braces of that head.

Steam is taken through a 1¼-inch pipe screwed into the front head, 13 inches above the top row of flues, and carried through the brickwork to the water columns, which are located on the side instead of the front of the boilers.

It was noticed by the men on duty several days before the accident occurred that the feed pipe entering boiler No. 1 showed occasional signs of water hammer, but by changing the rate of feed this disappeared. On the morning of the accident, soon after the day shift came on, a leak was discovered issuing from the back head of No. 1 boiler; this rapidly grew worse until the pump was unable to supply the water and the fire was smothered and the pressure reduced to about 25 pounds before the boiler could be cut out. Upon an examination it was found that the boiler was burned, and that over half the flues in the back head were loose, as was also the girth seam on a level with the center of the boiler. The boiler inspector was sent for and arrived just as the boiler was ready for service, and after examining the boiler both externally and internally pronounced it O. K., and the boiler was fired up and put into service again, but after running two or three days went down again and was worse than before.

It might be mentioned that before putting the boiler into service after the first accident, the water column was taken down and thoroughly cleaned and everything seemed to be in perfect order. When the boiler gave way the second time the writer was so thoroughly puzzled as to the cause of the trouble that the water column was ordered taken down again, and also the piping. Then it was that the trouble was located in the steam pipe which had become clogged near where it entered the boiler.

Why did this column work all right when the drain pipe was blown out and yet not permit pressure enough to show the proper water level? Also, how did this scale get into the steam pipe, 13 inches above the top flues? These boilers are insured and the inspector is a thorough and competent man, and has been inspecting boilers for about fifteen years and says he never saw anything of this sort before. Would it be possible for this to have happened if the steam had been taken from the top of the boiler? Or, would it not have been better to have had the feed pipe run to the back of the boiler, then across to the side and discharge on the side, inclining downward toward the front of the boiler?

With only two boilers and both of them in service night and day, carrying an overload the greater part of the time, and trying to efficiently supply the demands of a lighting service to the public, it puts a man in an awkward position to have one of the boilers fail him during the highest peak load of the year.

GEORGE C. WOODWORTH.

Henderson, N. C.

How to Apply for a Position

The reason why many engineers experience such difficulty in getting a position is that they fail to make a good showing when they apply. There is a great difference when applying for a job between maintaining a positive mental attitude and a negative, defeated manner. Let the man in you speak up with authority when asking for a position. Show those you approach that there is good stuff in you, that there is grit and vim and determination there. No one wants to employ a failure, a man who does not believe in himself. A great many employment seekers go on their quest in a half-hearted, discouraged and dejected way; they are convinced before they make their application that they are not going to get the place, and, of course, they do not.

The shrewd employer is very observant and nothing will escape his attention. He will look you over from head to foot and notice at a glance every detail of your dress, appearance and manner, your speech, the way you carry yourself, the degree of intelligence you manifest, and the extent of your education. All these count in his estimation, and if he gets a bad impression he is through with you.

What you think of yourself will have a great deal to do with his estimate of you. If you show in your manner and appearance that you have not much of an opinion of yourself, if you want to apologize for intruding upon his valuable time, or even for being alive, he will not waste a moment with you. You must think well of yourself or he will not think well of you. This does not mean that you should be brazen, or egotistical. It simply means that you are a man and should have confidence in yourself.

One of the leading business men in New York remarked that if he were looking for a position and possessed only $25 in money, he would spend $24 of it for a good suit of clothes, a hair cut and shave, and a good meal. This was his way of emphasizing the importance of appearance.

The average employer has not the time to go behind the evidences presented by an applicant of his fitness for the position, and it rests with the latter to plead his case in such a way as to convince the employer of his probable value.

Everything depends upon the strength of the impression you make. Just resolve before you approach him that you will make him sorry if he has not a position for you, and I guarantee that you will not be out of a job very long.

J. G. SHERIDAN.

New York City, N. Y.

Best Vacuum for Reciprocating Engines

I have read many interesting articles in POWER on the best receiver pressure, compression, etc., but very little on the best vacuum to carry for a reciprocating engine. For a turbine it seems to be a settled fact that the more inches we get the better, unless possibly in some cases where the cost of the apparatus required to obtain the higher vacuum more than offsets the saving. In a reciprocating engine, however, it seems to be taken for granted that 26 inches is the highest point of efficiency regardless of conditions. I think that the use made of the water coming from the hotwell should be considered, for if this water is wasted the problem is entirely changed, and the point of vacuum efficiency then depends only upon the amount of steam used.

I have a 26x60-inch Harris Corliss single-cylinder condensing engine. No use is made of hotwell water as we have more than enough from the other engines to supply the boilers. It is not convenient for me to experiment with the coal consumption as all the boilers take their feed water from the same tank and two of the other engines have water-wheel connections, so I must work from the engine itself, using the indicator cards and governor. The load on the engine at present is 250 horsepower and is practically constant. I took three cards at 26-inch vacuum, then took three cards at 29 inches, and found the vacuum was carrying 48.36 per cent. of the load at 26 inches and 52.67 per cent. of the load at 29 inches, a gain for the 29-inch vacuum of 4.31 per cent. A repeti-

tion of the experiment on the following day was even more favorable to the 29-inch vacuum, showing a gain over the 26 inches of 5.66 per cent. This proved clearly by the cards that the higher the vacuum the better, for an engine running under the above conditions.

As to the governor, I find that the balls can be run in a higher plane with the 29-inch vacuum than with a 26-inch, and the change in the governor is instantaneous with the change in the vacuum.

Now to the point: Why is not 29 inches better than 26 inches under the above conditions and why is not the plane in which the governor balls travel a good indication for the best point of vacuum. I should like to hear the opinions of other engineers upon this question.

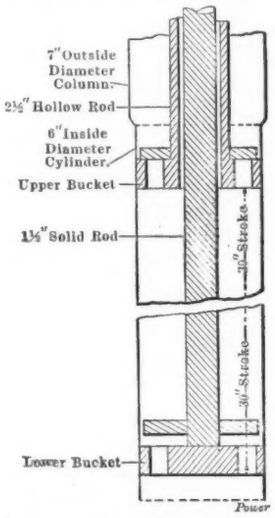
C. H. WILBUR.

Natick, R. I.

Capacity of Deep-well Pumps

The accompanying sketch shows a cylinder for a double-acting deep-well power pump. The two plungers are connected at the top, by means of the solid and hollow rods, to crank pins set opposite each other, so that one bucket moves up while the other goes down. These rods work through stuffing boxes located at the surface. The cylinder is submerged, no suction pipe or foot valve being used.

The question arises in figuring the theoretical capacity of such cylinders, neglecting slip and leakage, whether it is proper to assume the displacement of the



SECTION SHOWING BUCKETS

upper and lower buckets as being equal. Calculation plainly shows the displacement of the upper bucket to be about 82 per cent. of that of the lower bucket, but men familiar with the operation of these cylinders claim the theoretical capacity per revolution is twice the net volume of the lower bucket.

Perhaps some reader of POWER can tell me how to figure this out.

F. A. DEW.

Niles, Cal.

The Engineer versus the Indicator

Several weeks ago I was called to a large wood-working establishment to locate trouble with the engine.

Upon arriving at the engine room I found two men, one of them a man of perhaps 60 years, the other a younger man of about 30. Both of these men were good mechanics, the older being the engineer and the younger the "handy man." They had a new indicator of standard make and had taken several cards, making adjustments so as to get a good card, but still the engine ran bad. Both of these men were about to condemn the indicator. They said a man had been there some time before with his indicator and had made the engine run all right. As a result, they had decided that their indicator was no good, and had made up their minds to get one like his and sell the one they had.

Now the trouble was not with the indicator at all, but with the men. They, like a great many other engineers, thought that it was necessary only to make the indicator drum turn, then open the valves and press the pencil on the card. The stroke of the engine was 36 inches and they wanted a 4-inch diagram. If they had stopped to think, they would have seen that to get a correct card, the drum of the indicator must run exactly in time with the piston of the engine. But such was not the case. They had hooked the cord to the oil cup supplying the crosshead pin and this gave a cord angularity of about 6 or 8 inches. This, however, was not the worst mistake, for they had the instrument (which had a reducing wheel directly attached) connected up with a common twisted cord which stretched about 3 inches.

I had them make an angle hook to bolt on the crosshead, which brought the cord parallel and in a line with the piston. Next, we secured a good braided linen line and hung it up with a 10-pound weight for twelve hours, putting a small amount of beeswax on it before placing it on the indicator. After everything was ready I hooked it up and secured a card that showed the engine to be badly out. It was three seconds late on the head end and two seconds early on the crank end. After making adjustments to get a good card the engine ran nicely. I am sure that these men learned that the indicator is a good thing but that it must be put on the engine right or it is worse than nothing.

The thing to remember in placing an indicator is that the steam must come from the cylinder in as direct a route as possible, and the drum of the indicator must move exactly in time with the crosshead. I do not think anything is better to reduce the motion than a good reducing wheel. I have heard engineers say they do not like reducing wheels because the cord gets tangled up, but if a man understands the indicator as he should he will not have any trouble with the cord.

F. R. YANT.

Jackson, Miss.

Brains versus Temper

In the February 22 issue, under the caption "Locating the Pump Trouble," Mr. Lane writes that after having tried several ways of remedying the difficulty he began to use his head a little and arrived at the solution of his trouble. The article recalls to my mind how a somewhat similar pump trouble was recently located and it strikes me as being a very interesting comparison of methods.

The pump in question was of the ordinary duplex boiler-feed type. The engineer installed it and piped it up, but could not make it run. He sent to the factory, which was but a few miles distant, and they sent one of their experts to start the pump for him, apparently a very simple proposition, and yet the expert could do no better than the engineer. The pump just barely moved but would not run. He opened up the water end, took out the valves and turned them over, examined the piston and repacked it, opened up the steam end and scraped the valves and seats, looked over the pistons and tried everything that he could think of as being the source of the trouble. The frequent removal of the cylinder heads and covers almost wore out the threads on some of the bolts.

Working all day over it, with no change in the action of the pump, he was in anything but a happy frame of mind when he finally gave it up and went home. After he had gone, the engineer, hot, tired and dirty, stood looking at the pump and his feelings got the better of his temper. He held a heavy monkey wrench in his hand, and with an oath, threw it with all of his strength at the pump. His aim was a little low and instead of striking the pump fairly, it hit the drip piping on the steam cylinders and broke most of it off. Not wishing to leave it in that condition he unscrewed the remaining nipples and put pipe plugs in the cylinders. It was now past quitting time but he decided to give the pump one more trial just for luck. One turn of the throttle and the pump started off as if it had never known any trouble. He stood there in amazement, watching the pump, but was unable to figure how a monkey wrench applied in such a manner had cured the trouble.

The expert came back the next morning, found the pump running all right, and when informed of the occurrences of the previous evening, exclaimed: "I never thought of those drips. Now I remember that you had them all connected together with no check valves or stop valves on the cylinder connections. You

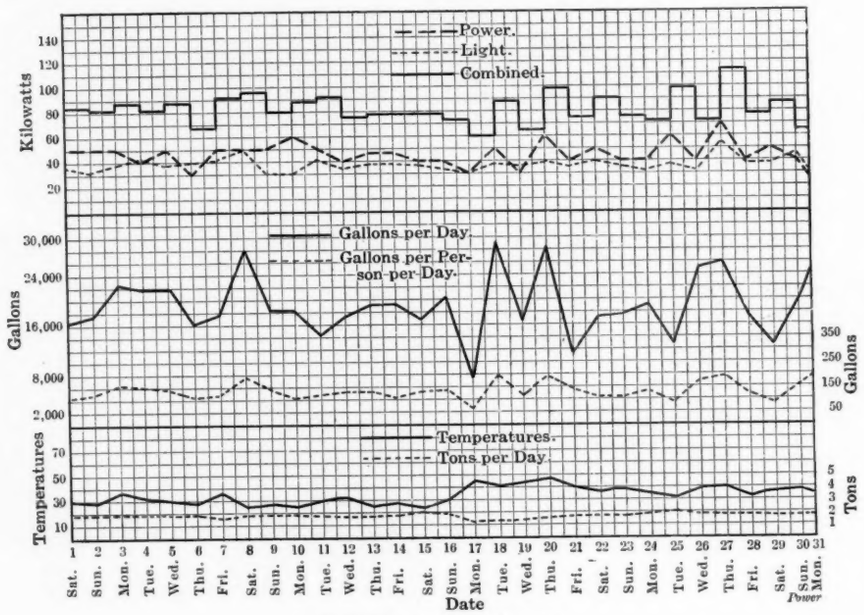
had one valve on the main pipe, beyond where they were all joined together and consequently had about the same steam pressure on both sides of the piston. No wonder it would not run. But it is strange that I never noticed it."

C. H. MAYO.

Holyoke, Mass.

A Convenient Method of Keeping Record

The accompanying chart shows one month's record of the building of which I have charge. I find it a very convenient method of keeping a check on the different departments which come under the headings indicated. The chart is self-explanatory.



RECORD FOR ONE MONTH

G. L. LYONS.

New York City.

Should Power House Attendants Know Costs?

This is a subject to which most managers seem to have given but little thought, and that little has been influenced largely by the more intimately associated purchasing agent, supply clerk and superintendent, who are jealous of their authority. I have had some experience along this line, and will mention some of it. I took charge of the power plant of a large manufacturing concern about a year ago, and in looking into their method of keeping records, I was informed by the purchasing agent that it was not necessary for me to know about costs, as he attended to all that, and would require from me a daily report of the material used.

I went to the superintendent who informed me that it was their method and that it had been found very satisfactory. I then laid the matter before the manager who had employed me, and informed him that if I were to assume the position, I must know the exact cost of everything used in the department. He said it was a most unusual request, and wanted to know my reasons. I explained to him, in substance, as follows: First, it was absolutely necessary to possess the above information that I might decide what to do in case of renewals and repairs, as to quality of material. Second, on his account, I should be able to present a proposition to him in dollars and cents, which would enable him to decide in five minutes what under their system would require days. Third, I demonstrated to him that because of the ignorance as to cost, thousands of dollars' worth of material was wasted in his plant every year. The toolmaker was approached and was dumfounded when shown that the piece of tool steel which he had carelessly thrown aside was worth his day's wages. An oiler was astonished when told that he was using lubricant enough in two days to pay his wages for two weeks, and that he might easily save his wages in oil, and still keep things cool. The engineer was shown that in packing a certain large pumping engine, it cost as much for packing each time as his pay amounted to for one month. He replied that had he known this he might often have gotten ten to thirty days' more wear out of his packing. The fireman, who seemed to have been so far down the scale as to escape the jealousy of the purchasing agent, had been told he was burning too much coal, but he thought the company had plenty of money, and was not giving him a square deal.

After this practical demonstration the manager formally notified the purchasing agent and superintendent that exact costs, including freight, etc., on everything used in the operation and maintenance of the plant must be furnished to the head of that department. This created a great commotion in the office, but was fatal only to their feelings, and within a week I had the operating force figuring. The toolmaker said, "There is five dollars' worth of steel in that tool, and I can repair it for one." The oiler found that saving two dollars' worth of oil and grease a day was like getting money from home. The engineer remarked that he could not understand how the concern had kept out of bankruptcy. The firemen were soon vieing with each other as to who could run his shift with the least amount of coal.

This idea is still saving thousands of dollars each year. The men are more intelligent, are more in sympathy with their employer, and are more thrifty and prosperous themselves. It seems reasonable that an employee who cannot be trusted with the exact cost of everything he uses is not worthy of employment. No business can reach its maximum success until every employee knows at the end of his day's work whether he has made or lost for his employer.

T. J. BLASS.

Chattanooga, Tenn.

Oil Grooves in Bearings

Quoting F. L. Johnson in his article "How to Babbitt a Main Bearing," printed some time ago, "oil grooves are erroneously supposed to assist in the distribution of oil," I should like to know how many engineers are successfully operating engines with grooveless bearings. Engine bearings will wear more or less in the course of time and when a bearing commences to show undue amount of wear, more heat than usual, and will not stand any keying on account of overheating, the average engineer will look to the grooves, expecting to find them more or less clogged up. By a few moments' work with a bent round-nosed chisel, hammer and scraper he soon has a bearing good for another long period, and one which will again permit of close keying with minimum wear and heat.

I know of an engineer who, contrary to the advice of the engine builders, cut ten elliptical oil grooves in each slide of a 22 and 44 by 48-inch Corliss engine, oil being fed to the slides in slow drops. Although the engine is in service eighteen hours every day in the year and has been running twelve years, the shop-tool marks are still plainly visible.

Mr. Johnson wrote a very valuable article on babbiting bearings and does not merit any criticism, however much our opinions may differ in connection with the oil grooves.

W. C. LIGHT.

Painesville, Ohio.

SUBJECTS *under* DISCUSSION

COMMENT, CRITICISM, *and* DEBATE *upon various* ARTICLES, LETTERS *and* EDITORIALS *which have* APPEARED *in* PREVIOUS ISSUES

Starting a Water Works Pump

Having worked for 18 months in one of the Chicago water-pumping stations in which there are three 20,000,000- and one 40,000,000-gallon, triple-expansion, Worthington pumps with the high-duty attachments, I may be able to give Mr. Tucker an idea of the manner in which these pumps are started.

The top of the air chamber is connected, by means of a pipe, to a cylinder called an "accumulator," shown in the accompanying sketch, which contains a piston and rod, the rod being called a "ram." The unit pressure of the air on the top of the accumulator piston is the water pressure against which the pump is working. The pressure of the water surrounding the ram will therefore be the accumulator pressure multiplied by the ratio of the area of the ram to the area of the accumulator piston.

The compensating cylinders and the pipe leading to the ram are filled with water, and the ram and accumulator piston move up and down as the plungers in the compensating cylinders move in and out with the strokes of the pump.

The first thing to do when starting is to open the suction and discharge valves. Then pump air into the air chamber by means of an air pump until the chamber is two-thirds full of air, which condition can be ascertained by looking at the gage glass on the air chamber. The ram is then raised by pumping water into the compensating system. When the ram is about one-third up (which can be seen by looking at the tail rod on top of the accumulator), no more water is pumped into the system.

The valve on the pipe leading to the air chamber is now opened, which allows the air pressure from the air chamber to act upon the piston and ram of the accumulator.

The next step is to create a vacuum on the condenser and low-pressure cylinders by means of a pump which exhausts the air from the condenser and low-pressure cylinders. When the vacuum gage registers about 15 inches, the throttle is opened and the pump started. After making a few strokes the pump, maintaining a vacuum on condenser, is stopped, leaving the pumping engine in service.

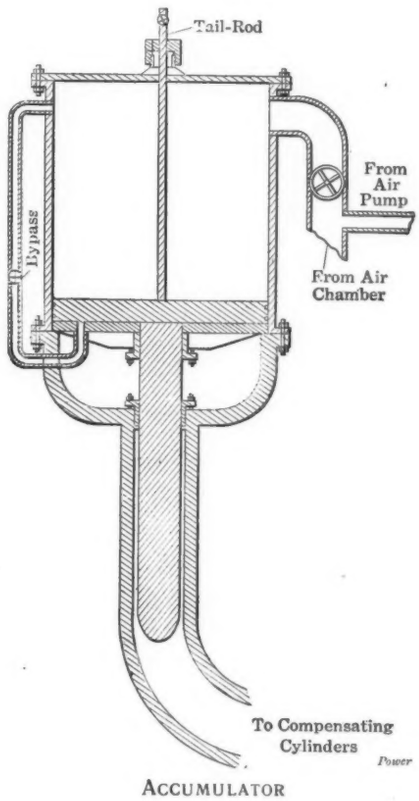
Should the pistons strike the heads, air is allowed to pass through the small bypass from top of accumulator piston to the bottom, thus raising a back pressure which lessens the pressure on the ram and consequently on the compensating cylinders, thereby shortening the stroke and preventing the pistons from striking the heads.

FRED L. WAGNER.

Chicago, Ill.

[The following additional instructions were obtained from the manufacturers and should be observed in connection with the above.—EDITORS.]

Before starting, the steam cylinders



ACCUMULATOR

should be thoroughly warmed by turning on the jacket steam.

After raising the accumulator ram, open all the bypass valves on the water cylinders.

After exhausting the air from the condenser, blow off the back-pressure tank and make sure that the latter is free from water.

In starting, first open the main throttle about one-half a turn, then open the side throttle of the leading side and when the piston has made full stroke close again. Do the same with the other side throttle. Repeat until the engine picks up.

As the speed increases the stroke will lengthen and more back pressure should be given to the accumulator pistons.

When the engine is fairly under way, close all water-cylinder bypass valves.

The stroke is controlled by varying the accumulator back pressure.

Under no conditions should an engine be started up with a high-duty attachment, unless the water cylinders have first been thoroughly primed.

If the engine does not make a smooth stroke, but pauses at the center, the high-pressure cutoff should be lengthened, and the engine should be so adjusted in its valve motion that each cylinder cuts off at the same point on each end. As a rule, they operate best, cutting off at 0.3 to 0.4 stroke in the high-pressure, 0.5 in the intermediate, and 0.75 in the low-pressure cylinder.

A Few Pointers on Compression

It seems singular that the first practical proofs in favor of compression should come from the home town of the champion of noncompressionists (F. L. Johnson). I believe, however, that before

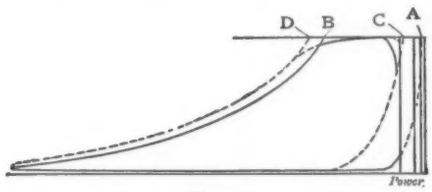


FIG. 1

making any changes in the setting of our exhaust valves, a few details which, through sheer inadvertence no doubt, were omitted from the article by Mr. Waldron should be given. I gather from the article that the engine is a Corliss, with a single eccentric. As the eccentric was not moved, it follows that changing the point of compression also changed the point of release. The diagrams shown in Fig. 2 of the article do not show any change in this respect. In presenting the diagrams, why were the scale, the revolutions per minute, etc., not given so that the figures could be verified and the point of actual cutoff drawn? If a horizontal line is drawn representing the initial pressure in the cylinder and the compression curve is continued to meet this line and the amount of steam used as represented by the distance on the initial-pressure line from the compression point to the point of cutoff is measured it will be found that the 7 per cent. clearance space is not filled at

the expense of 1.73 per cent. increase in the real cutoff.

To make it clearer I have illustrated it with one end of a pair of the diagrams presented. In the absence of definite figures, I cannot presume that these are correct; still I believe they are near enough to prove that his conclusions are not warranted by facts. In Fig. 1 the line *A B* represents the steam used without compression, and *C D* the steam used with compression. This, then, cannot be the reason why the engine ran a longer time with compression in the first test. In these tests I have not the least doubt that the engine was correctly timed, but I do doubt that the number of revolutions was correctly counted, and for this reason. He concedes a later cutoff with compression than with no compression; hence, it is logical to conclude that the engine must be running at a lower rate of speed with, than without compression, and that the steam in the boiler lasted longer in the former case than in the latter; but the number of revolutions made by the engine should be about the same, though a slight increase is bound to appear in favor of compression, due to the longer time allowed the boiler to cool. It is interesting to conjecture what kind of diagrams would be obtained from the engine in the two cases. When it was carrying steam the full stroke with steam, say, at 10 pounds pressure, a diagram something like Fig. 2 would be obtained with no compression; and with compression a diagram like Fig. 3 I think would be the result.

No wonder then that the engine ran but 18 minutes after starting, taking steam the full stroke in the first case, while it ran 25 in the second. The engine could

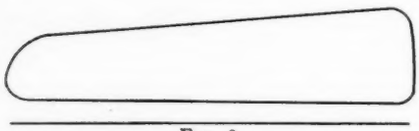


FIG. 2

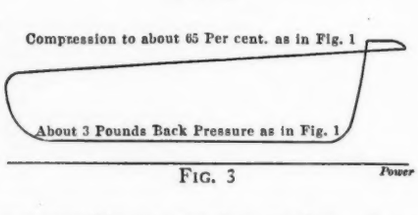


FIG. 3

not possibly be running as fast. I am sure several readers would feel obliged if the following data concerning the tests can be furnished: Make of engine, single or double eccentric, degree of the crank circle at which the steam valve opens for lead, exhaust valve closes for compression and opens for release, exact number of revolutions, boiler pressure, length of time the mill shafting was run before making test, temperature of the mill and scale of the indicator spring.

I hope the article, however, will prove that the hight assumed by the governor, after a certain change in the valve setting, does not always indicate whether the engine is using more or less steam.

L. M. LESLIE.

Cambridge, Mass.

Boiler Tube Failures

In discussion of the editorial in POWER of April 12, on failures of tubes in water-tube boilers, I wish to point out that such failures divide naturally into several classes.

First, there are failures directly chargeable to scale, sediment, oil or any foreign matter. Perhaps the larger number of failures properly come under this heading. The tube will show one or several bags that may vary in size from 1 to 3 inches in diameter with a 3½- or 4-inch tube. In some cases, one bag will overlap an adjoining one and under some conditions a series of bags may extend for 24 to 36 inches. The metal is burned or overheated. The depression is sharply marked and usually truly circular. Oftentimes there will be a rupture in the center of the depression and now and then the rupture will extend from one bag to another. In most cases, the rupture is small, not more than ⅛ inch in size, and water hissing on the fire will call attention to the tube. Infrequently do bagged tubes, as above described, rupture seriously.

With ordinarily good water, we may have many bagged tubes in the bottom row due to the following causes: Consider the water to be in active circulation and to contain loose scale which is carried through the tubes. If the fire doors are opened, a vast amount of relatively cold air is projected onto the lower tubes, resulting in a sudden cessation of circulation. The scale moving through the tubes falls when the cold air strikes. When the firing is completed the doors are closed and the temperature is raised to normal. Before the circulation becomes active again, the tube is overheated and bulges. The circulation at this point, starting up violently, carries away the loose scale and the bag becomes cooled by reason of water again wetting the metal.

With oil, alone or in combination with scale, the overheating is different and more pronounced and it covers a larger area. The initiated can readily distinguish between the two and assign the cause. The peculiar thing about oil in boilers is the fact that it is practically impossible for people to understand that oil is dangerous and will give trouble until they learn through costly experience. The frequent failures in the navy may probably be due to oil, owing to the use of surface condensers. Oil extractors have not thus far removed all the oil. It appears that animal oils are far more elusive than mineral. A glance at the water glasses on marine water-tube boilers shows the usual grease line commonly found when oil is present. Ruptures due to oil or oil and scale are vastly more serious than those due to scale alone; therefore, oil should be absolutely absent. That tube will never be designed which is proof against overheating due to oil.

In many cases the men in charge are unable to read the signs indicating the presence of oil as given by the tubes. The quantity is so minute that it escapes the eye and touch. Often the inspector is deceived. Persons who have given the matter close observation and study are able to detect the symptoms and prescribe the remedy, soda ash. In cases of doubt one should use this liberally, and employ the litmus-paper test to be sure that the proper amount is present at all times.

Tube failures from the causes just mentioned are, of course, preventable, but often the remedy is not in the hands of the operating engineer. His plant may be short on boiler capacity and he may not be able to have more boilers installed. Often there is not time enough allowed to cool off and clean a boiler and the cleaning of water-tube boilers properly requires time. To cool down slowly so the scale will be softened and to run a turbine cleaner through every tube requires from 24 to 48 hours, depending on the conditions. It is an engineer's duty to lay such matters before his employers and urge that the conditions be improved so as to avoid tube failures.

Another cause of failure is found in water-tube boilers of certain designs wherein circulation is restricted which results in the tube being overheated. If the water in the tube is confined in a small space and the circulation is toward a given point, then if by reason of a great head of water, or by tortuous passages, or by the interference with discharges from other tubes, the free travel of the steam in its movement upward be interfered with, the contents of the tube will not be solid water but a mixture of steam and water, the proportions of which will vary with the intensity and size of the fire. Especially is this true in high, vertical, water-tube boilers using waste heat at very high temperatures. Designers have not, in the writer's opinion, given the matter proper thought; otherwise, conditions would be changed so as to distribute the heat entering the tube chamber over a larger number of tubes and thus reduce the liability of failure.

A tube cannot be designed which will successfully withstand overheating as above outlined. Add to the conditions just described even a minimum quantity of scale or a trace of oil, either animal or vegetable, and a hospital will be the necessary adjunct.

To minimize the danger from existing conditions, special care should be given

to cleaning; ample boiler capacity should be provided and overloading and forcing should be avoided. True, with some water-tube boilers it is possible to get an evaporation 50 per cent. above rated capacity easily enough, but there will be proportionally more scale and greater liability of having half water and half steam in the confined walls of the tubes nearest to the first pass of heat. I have examined boilers which had been forced to such an extent that the generation of steam was so great where the heat struck the tubes near the rear water leg that the circulation was reversed, the steam flowing up the rear leg between the fires and resulting in frequent and disastrous failures of tubes in the lower row. The remedy was, obviously, more boiler capacity.

The failures due apparently to inherent structural defects in the tubes, defects that are exceedingly difficult to detect at the mill or boiler shop, appear to be on the increase. Especially is this true of lap-welded tubes, both iron and steel. Twenty-five years ago we had excellent charcoal-iron tubes and failures due to poor quality of material were practically unknown.

Operating water-tube boilers then with feed water carrying 45 grains of solids per gallon and using feed water from a jet condenser at a temperature of 120 degrees, I had trouble, of course, with bagged tubes. The tubes frequently opened up. But in no case did one open for more than one inch. An overload of 50 per cent. was carried. Today we find many cases of ruptures that are serious. A recent accident in Jersey City may be cited. The boiler had been designed for 200 pounds pressure, had been used for several years at 150 pounds and had been tested at least twice to 300 pounds water pressure. A 4-inch tube, well above the bottom, failed. Instantaneously, the rupture extended for 9 feet. The tube failed at the weld; pulling out of the front connection, it spread out almost flat. The fireman was killed. Examination disclosed a spot where the metal was spongy and at which, probably, the initial rupture took place. Similar cases may be cited of failures due to structural defects which have resulted in injuries to persons and loss of lives. For commercial reasons matters of this kind are frequently concealed. Failures are not confined only to the lap weld, as might be supposed. Cases are found where the failure consists of a usually oblong section of the tube dropping out and leaving a hole in the otherwise sound tube. In some instances of this kind of defects, laminations have been found, previously undiscoverable, which accounted for the failures. In other cases the scant reduction in sectional area at the point of fracture, together with an absence of signs of overheat, indicates a poor quality of metal at the point of failure. Chemical tests would, no doubt, reveal inferior metal. But it is not possible at all times to secure such tests, owing to costs and other considerations. Under such circumstances it is clearly up to the tube mill to explain. Unfortunately such explanations are not forthcoming thus far.

That the lap-welded tube, either of charcoal iron or bessemer steel, is all right for fire-tube boilers is unquestioned, but in my opinion the drawn-steel tube, made of open-hearth steel of best quality and having the inner and outer circles parallel to a given gage, is the proper tube for water-tube boilers. In addition, with the high pressures required today, we should use a tube of heavier gage. True enough, all rules pass a 4-inch tube of No. 10 Birmingham gage (0.134 inch thick) for 200 pounds working pressure. The strength of the tubes is based largely on water tests to destruction. But water tests are more or less misleading. In service, the water in the tube is often not solid. The cost of having a 4-inch tube made to No. 8 or No. 7 gage is not relatively great, but the increase in strength and durability is very large and this increase would tend to improve the metal against structural or inherent defects in making the tube.

To sum up, then, we need, in order to minimize the number of tube failures, feed water free from scale or oil, seamless tubes of open-hearth steel and of thicker sections, and a knowledge of when the evaporation per square foot of tube surface exposed to the highest temperatures has reached the safe limit, in any given boiler.

T. T. PARKER.

New York City.

Central Station versus the Isolated Plant

In a recent issue of the *Engineers' List* there appeared a note commenting on an article on the above subject which was published in the *National Engineer*. The author of the article congratulated the National Association of Stationary Engineers on the fact that he never knew of but two plants in charge of National Association of Stationary Engineers' men that had been taken over by the Central Station.

As one of these plants must have been that of the department store of Marshall Field & Co., Chicago, which is under the supervision of Charles T. Naylor, a past president of the National Association of Stationary Engineers, and a man of distinguished ability and attainments, the *Engineers' List* wanted to know how the Central Station was able to capture it.

A request to Mr. Naylor for the facts in the case brought out the following reply:

EDITORS.

"The Central Station 'captured' the plant by offering a low rate and has made good. The service has been practically uninterrupted and almost perfectly satisfactory. Seven million kilowatts of direct current at 230 volts were furnished in 1909. The load varied between 8000 and 15,000 amperes for the average and ran up as high as 22,000 amperes for a peak in the busy seasons. The working hours are from 8 a.m. to 5:30 p.m. The business is a retail dry-goods store and *not* a department store as is frequently published. There are 70 electric elevators, a multiplicity of motors for pumps, of capacities from 100 horsepower down, and the equivalent of 6000 incandescent lamps, most of them of the Nernst, glower type, for illumination.

"'Will the isolated plant be able to withstand the onslaught of the Central Station?' is a question that is worrying the operating engineer who is looking to the future of his activities as a wage earner.

"The isolated station is reducing its cost of operation, but slowly. The Central Station is lowering the cost of current generation rapidly and is each day becoming better fitted to compete with the private plant.

"Current cost, in cents or mills per kilowatt-hour, is going to decide the above mentioned large and important question. It may be set down as a safe proposition that more and more isolated plants are going to be put out of business each year by the Central Station, simply because it will be cheaper to operate on the latter service.

"In congested city centers where land is dear or space valuable, the private plant must go the way of the private water works and private gas plant, and power and light will be drawn from the street mains, like gas and water, as a matter of course.

"When one takes into consideration the noise, dirt, danger and labor that accompany a power plant, it seems foolish to consider anything but Central Station service if the relative costs are nearly the same.

"In the case of a large dry-goods store, in a central city district where ground is worth $100 per square foot and basement-floor space worth $3 per foot per year, where coal has to be hauled two or three miles by wagon, where condensing water cannot be had, where the street frontage is required for patrons' carriages and cannot be given up to coal or ash wagons, where high-pressure steam is an element of danger to tens of thousands of women who throng the store, where a million or more dollars must be sunk into engines, boilers and generators, one has a right to stop and ask himself, 'Shall it be a private plant or shall it be Central Station service?' If it costs you 1 cent to make current and 2 cents to

buy it, you probably had better make it. If it costs 1½ cents to make and 1¾ cents to buy, you should buy it. If one can buy for 1¼ cents current which would cost 1½ cents to make, the saving will go a long way toward paying for the live steam required to heat the premises.

"Fuel for heating, when thrown into the scale, often decides for or against the Central Station, generally against it. The cost of heating with live steam may run as high as $1.25 per season for each 1000 cubic feet of space heated when all the items are included, such as labor of handling the fuel, etc.

"On account of the large amount of current used in the warehouses and other buildings, as well as in the main store, we are able to obtain a very favorable rate.

"CHARLES T. NAYLOR.

"Chicago, Ill."

Belt Troubles

In the March 1 issue, G. B. Kamps tells of his belt troubles. He assumed that the belt had stretched more on one side than on the other. Now if his belt ran off on the right side, when reversed it should have run off on the left side, if his theory was true, but it did not. Scraping the belt did not cure his trouble, either.

His alternator was not in line with the main driver. As soon as he shifted the alternator enough to make the pulleys line up, his trouble stopped. He claims that the amount of shift must be small, else the belt tends to run to the high side. This statement is not exactly true; if shifted too much, the alternator would be out of line in the other direction and the belt would run off in the opposite direction. What he says about the belt crowding to the high side is a different

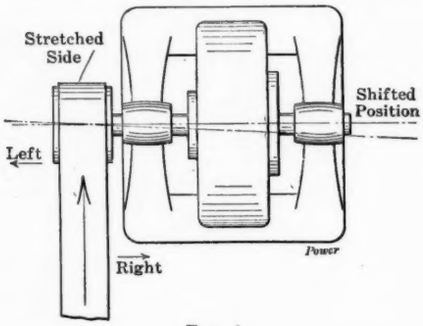


FIG. 1

thing. In his sketch of the alternator in the shifted position, I assume the side marked "stretched side" to be the high side of the pulley, but as he did not indicate the direction in which the belt was running, I cannot determine if this is the high or the low side.

In Fig. 1, shown herewith, the alternator is in the shifted position; the belt, in this case, would run off on the left or low side. If the alternator were to be run in the direction opposite to that indicated, the belt would go to the right or high side. If anyone happens to get puzzled as to which way to shift the alternator or shaft, let him take a lead pencil, piece of pipe or any cylindrical object, and place a two-foot rule on it at right angles to it and push it, first in one and then in the other direction, as shown in Fig. 2; the rule will stay in the middle of the roller. But if the roller be set at any other angle, as in Fig. 3, by pushing the rule toward *A* it will crowd to left and by pulling the rule back toward *B* it will crowd to the right side. This experiment will show that there is no high side. The pulleys and shafts must be in line to run right. Pulleys with large crowns will run fairly well even when the shafts are not exactly in line. Too much crown, however, has a tendency to stretch the belt and shorten its life.

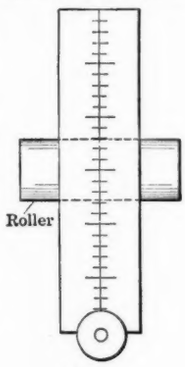


FIG. 2

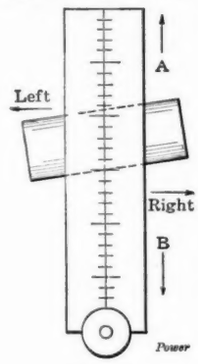


FIG. 3

JOSEPH RYAN.

Spreckels, Cal.

Beware of Corrupt Salesmen

I was very glad to see the letter by L. W. Chadwick, "Beware of Corrupt Salesmen," in the March 22 issue.

If honest engineers and purchasing agents would "beware of corrupt salesmen", they could do more to stamp out the graft evil than can possibly be accomplished by legislation. Reform must begin from within. Salesmen who stoop to dishonest practices try to appease their consciences by saying "If I don't do it the other fellow will and I might just as well get the business because our goods are all right and if I don't turn in a certain amount of business I will lose my job." It certainly is a mighty strong temptation and it is no wonder that many fall a victim.

I really believe that those engaged in offering the bribes would be glad if the practice could be wiped out.

Engineers who are uptodate and who keep close track of their departments are in a position, at the end of each year, to show just how much money has been saved for their employers because of money-saving methods adopted. Such engineers, I believe, are almost invariably appreciated by their employers and have salaries based upon their worth. It is bothersome and takes time to keep accurate track of details but that it pays to do so is hardly a subject for argument. Engineers are very rapidly growing to realize the wisdom of keeping track of details. My belief is that the graft problem is gradually becoming solved in this way.

I hope that there will be a frank and full discussion of this matter both from engineers and supplymen, of which latter I am one.

Let us band together to wipe out the graft practice that is sapping the vitals of the characters of all who are engaged in it.

CHARLES F. CHASE.

New York City.

What Causes Chimney Failures?

I note in POWER for March 15 the question "What Causes Chimney Failures?"

I have designed a number of chimneys and never had but one crack to my knowledge. The one which did was small, being 15 inches square inside at the top and 75 feet high. Because of limited space at the base, it had very little taper and I told the owners that it would be necessary to give the contract to a first-class builder. However, they gave it to a builder who was somewhat noted for skimpy work. The gases in this chimney were over 1000 degrees in temperature and it soon gave out.

All the other chimneys which I designed were round in cross-section.

I do not like to have the gases come in contact with the outer shell and always built an inner one so as to avoid as much expansion and contraction of the outer shell as possible.

Pure lime never sets. Lime mortar has adhesive qualities if the bricks are wet when laid. It hardens when exposed to the air. If old lime mortar be put into water, it will disintegrate; the lime will separate from the sand. Lime mortar must be made up so that it may be handled easily with a trowel. One part of lime to five of sand is a very good mixture for this. The lime and sand should be mixed several days before using and properly tempered for use at the time it is needed. For tempering I put in portland cement, one-half part to one part of lime. I mix the cement with water before putting it into the lime mortar. When put in dry, it is liable to be lumpy and it does not become mixed as thoroughly as when used wet. All brick should be thoroughly wet when laid. No more mortar should be mixed than can be used on the day of mixture and any left over at night should be thrown away.

I put a band of ½x4-inch iron at the

bottom and the top of the flue opening. It is placed back of the outer course of brick. A similar band is built into the shaft every 20 feet in hight.

One of the brick chimneys which I designed stands at the foot of Gold street, Brooklyn. It was put up in 1899. It stands on a concrete foundation, supported on piles. The top inside diameter is 13 feet 6 inches and the hight is 200 feet. It was built by John W. Ferguson, of Paterson, N. J.

I have not seen this chimney since it was built and would be pleased to know if there are any serious cracks in it.

This chimney was built for about $1000 less than any price we could get from steel-stack builders.

I have always felt some concern about the inner shell. The building laws of Brooklyn require a firebrick lining for a hight of 30 feet. With firebrick, the lining cannot be made as strong as when it is all composed of red brick. I heard of one case where a lining like this failed and all of it fell to the bottom. If anything should happen to the inner shell of that Brooklyn chimney, I should want the blame put upon the city of Brooklyn rather than upon myself.

I once designed a chimney, 10 feet 6 inches in diameter by 150 feet in hight, for a small town in Pennsylvania. There were no mason contractors in that vicinity that had ever built a chimney and no one wanted to undertake this one, so a hollow-tile chimney was put up which cracked quite badly. I think that the builders of these chimneys would have less trouble if they would put in an inner shell.

W. E. Crane.

Duluth, Minn.

Oil in Refrigerating Plants

Oil is a poor conductor of heat and this quality will be found extremely objectionable in refrigerating coils. Too much care cannot be exercised in keeping it from entering the system. As a rule, the oil separators on the discharge pipe are not large enough and the oil passes through to the condensers. The charge of ammonia in nine cases out of ten is too small and consequently in the liquid receiver the oil has no time to settle, but passes from there to the evaporating or expansion pipes, much to the detriment of the work done.

As cleanliness is of paramount importance in the boilers of a steam plant, so it is in the expansion coils of a refrigerating plant. The writer has seen both vertical and horizontal, single- and double-acting compressors working without oil for months. Unsuitable packing, widely varying temperatures of ammonia gas due to varying work or poor regulation of expansion valves, worn rods and too much monkey wrench, are often responsible for the introduction of oil through the piston-rod gland.

Fortunately remedies are at hand for these troubles. Strenuous salesmen are willing to sell good packing and good advice is often thrown in, free. Manufacturers in many instances very wisely send around good practical engineers who will not only supply the goods but will properly apply them without charge. Thermometers as well as pressure gages on suction lines will do wonders in the way of making it possible to keep the temperatures within close limits, while the cost of truing up the rods is insignificant when it is considered how much improvement is made in the life and service of the packing. The monkey wrench will be taken care of if the preceding pointers are observed.

Frank H. Williams.

West Haven, Conn.

The Operating Engineer

The editoral in Power, March 29, 1910, was timely and to the point. It shows that the editor knows what is wanting; it proves that engineers are thinking and that ere long the operating engineers will, through their own efforts, elevate their calling through the Institute of Operating Engineers and in such a harmonious manner that it will benefit all existing engineering societies promoting the standard of our efficiency intellectually, morally and socially.

Never in the history of engineering has there been so much time, thought and energy given by school, college and State for the upbuilding of engineering science, be that the civil, mechanical or operating branch of the profession, for the reason that engineering skill is one of the foremost national requirements.

Agriculture is the foundation of humanity's existence. Farming would be inadequate today were it not for engineering. To preserve the natural resources of our land requires the earnest endeavor of the farmer and the engineer who are intrusted with this vast responsibility.

The farmer and engineer are in much on the same boat: One produces the necessities of life, the other produces the necessities of commerce.

The modern operating engineer is the result of practical evolution; he represents the harmonious blending of the practical and technical branches of engineering; his trade is never learned, the hours are in many cases needlessly long, his environments are artifical during his hours of labor and the compensation is too small to meet the advanced theory of righteous economy.

Those who have traveled the long journey from apprentice to chief engineer know the difficulties attending any attempt to establish the fact that engineering is no longer a trade, but has risen to the distinction of a profession and should be classed among the necessities of life. Even the dead must pay homage to engineering advancement.

The first requirement in any calling is ability, the second is a market in which to sell that labor to the highest bidder, and the third that the transaction is a benefit to humanity in general.

Education is a jewel that money cannot buy; it can be acquired only by earnest labor, experience and self denial. It is true to nature. If acquired rapidly it dies early; therefore an early technical education in many cases is a fallacy. In youth the receptiveness is keen, retentiveness lacking, and stability an unknown quantity. Few men realize their mission on earth before they are 30 and very many must admit that they are failures when compared to their predecessors. To excel those who have gone before is a duty not to be shirked by honorable men.

The modern idea of a college education is to get in easy, despise work, making up any inefficiency by practising substitution, thereby promoting educational debauchery and national downfall. These are stern facts and are the results of the times. We are traveling so fast in our desire to become rich that we care not for tomorrow nor posterity. The youthful collegiate of ability is to be pitied. His constant effort is to build up a reputation, and for the want of experience sells his labor to the unscrupulous parasites that unfortunately exist in engineering enterprises. The engineer's charity is so extensive that by allowing these wrongs to exist, he invites retrogression and fails to fulfil his mission.

The branch of operating engineering has become so vast that it behooves those who are fortunate enough to possess the ability required to perpetuate and elevate the calling, by making the journey interesting and mutually beneficial. It is a case of the older men giving the younger men of ambition a lift. To do this an apprenticeship system must be established, because a proper apprenticeship inculcates discipline and eradicates erroneous doctrines. Here the youth comes in contact with his life's study by easy, natural steps; his education is developed slowly by observation; his mind broadens by contact with matured men, who give him an opportunity of finding himself and see if he possesses the ability and liking for the calling. If not qualified, let him retire while there is yet time. He may decide to become a mechanical engineer or a chemist and has still time to apprentice himself to those professions; at any rate he has learned to work, how to spend money judiciously and that life is a serious matter.

Should the embryo engineer decide to

proceed further, he passes a prescribed examination that qualifies him to higher rank and greater achievements and necessarily more responsibilities. Thus he continues until at last he reaches the summit of his ambition. He is now in duty bound to aid those who are to follow, perpetuate the craft and bring honor to the fraternity by becoming a plant manager, thus fulfilling a mission worthily won.

A proper engineering course in a reputable college is the ambition of every progressive engineer. After the practical elementary training, the need of the higher mathematics, etc., becomes more and more apparent, and the difficulty, financial and otherwise, of obtaining it, becomes greater the older the student becomes. Here we are confronted with good material becoming dormant for the want of assistance. This fact has long been known among engineers, and a well laid-out plan by practical engineers has been devised for the purpose of abridging these difficulties and bringing an appreciation of the importance of engineering to the general public.

The truth is, there is a scarcity of engineering skill; there is a scarcity of embryo material; the advance in engineering was so rapid and the demand so great that engineers were created before they were qualified to fill with dignity the position; this gave rise to the carelessness of our present generation.

Future policies must be built on the past experience of able men.

G. J. MILLER.

Brooklyn, N. Y.

The editorial, "The Operating Engineer," in the March 29 issue of POWER is one that I am sure will meet with the approval and coöperation of the higher class of operating engineers throughout the country.

As I am thrown into contact with thousands of operating engineers every year, I have had an opportunity to make a few observations and will endeavor to bring them out herein.

In the first place, I find that in the majority of cases the operating engineer is not much of a business man. This I can account for by reason of his practical isolation from the business world, being, as a rule, confined to the plant where he has but few visitors and those generally are in the profession. Occasionally, of course, you will find a man who at some time has been an oil or packing salesman or machinery representative. In a way, this lack of business knowledge handicaps him, and he, accustomed to *receiving orders* from the "old man," is very seldom allowed to exhibit any initiative. In a sense, this is due to the great number of men operating plants who have neither the ability nor initiative to propose anything in the way of improvements to effect economy and, as a rule, the "old man" regards engineers as a class and not as individuals. This brings up the question of grades and classes of engineers; verily they are legion.

There is the man who first obtains a position as fireman because there is nothing else in sight and after a short period probably gets into the engine room to relieve the engineer for a day or two. When the engineer leaves the fireman is put into his place and a new fireman is obtained. In his new position, this man fumbles through for a month or two until the plant is practically racked to pieces and then the "old man" fires him, cussing engineers (?) in general.

Again, we have the man who goes into the business as a trade and after serving the first few years as a fireman is promoted, successively, to the positions of oiler, assistant engineer, engineer and probably chief of the plant. This man gets his knowledge in the "college of hard knocks" and is an all-around, practical man, but never reads nor studies as he does not want to be a "book engineer" like the correspondence-school man who is running on the opposite shift and has picked up the business probably in half the time. A pure case of jealousy I find very often.

In other cases, we have the man who is the product of an apprenticeship in the boiler room, machine shop and engine room, a thoroughly practical man, well versed in his profession, a student, and considered to be of the highest type of operating engineer, with ambition to be of real service to his employers. This man is in the minority, I find, probably because there seems to be no great prospects of increase in pay or social distinction in spite of the efforts made to overcome the prevalent idea that an engineer is "a greasy individual of small attainments filling an unimportant position and commanding a correspondingly low wage," to use the words of the editorial.

There are a great many other types of engineers, but these few illustrate my point.

When one considers the necessary requisites of an operating engineer in the modern power plant and then compares him with the ordinary, strong-armed steam fitter, drawing very often a larger salary, it seems as though it were time to educate employers to give a more adequate consideration and remuneration to the man who is responsible for the operation and care of the power plant.

The institute of operating engineers, in process of formation, mentioned in the editorial, seems to solve the problem of at least raising the standard of the operating profession and in time will, no doubt, bring the employer into closer touch with the man whom they now regard as one of the "hands."

I trust that this will become a national movement and that other men will be heard from through the columns of POWER.

EDWARD A. JEANSON.

Oshkosh, Wis.

Rhode Island Coal

I was much interested in the articles in POWER on the subjects of Rhode Island coal and the so called aids to combustion, in the issue of February 22. In reading the article, "More Information on Rhode Island Coal," I noticed a statement by Mr. Williams, in his answer to Dr. A. H. Gill, to the effect that by using a solution of calcium chloride, they were going to make a coal burn which nobody, heretofore, has been able to make burn. In my mind if that statement has reference to Rhode Island coal, which is, or was, mined at Portsmouth, R. I., Mr. Williams is laboring under a huge mistake. My reason for making this statement is that I have burned Rhode Island coal, mined at Portsmouth, in cook stoves, heating stoves and under steam boilers using natural draft, and under steam boilers having forced-draft systems of the steam-jet and blower types and I can truthfully say that I never had occasion to use any of the so called aids to combustion.

If lime is helpful in making Rhode Island coal burn freely, why not use the water which is pumped from the Rhode Island mines to give the coal a bath, for the water taken from these mines is saturated with lime and magnesia.

I was surprised that neither Mr. Williams nor Mr. Sawyer made any remarks in regard to the pecularities of Rhode Island coal. To my knowledge it has three characteristics: When it is used under a steam boiler with forced draft it has a very decided tendency to run together, or to slag. This is so marked that the fireman must keep a sharp lookout for his steam pressure and use a slice bar continually, to keep his fires open. Rhode Island coal is about 20 per cent. heavier than most of the Pennsylvania anthracite. The other peculiarity of Rhode Island coal, which I have noticed, is that when heated to a dull red color it is much slower in cooling off again than is the Pennsylvania coal.

MICHAEL H. HARRINGTON.

Fall River, Mass.

The Navy Department recommends an appropriation of $10,000 for prizes, etc., to be awarded ships in commission for general efficiency and economy in coal consumption. It is estimated by the department that competitions of this character have resulted, and will continue to result, in a saving of 10 per cent. in coal consumption. In the course of a year this will mean a large amount of money.

Artificial Systems of Refrigeration

By C. P. Wood

There is a great field for the practical application of artificial refrigeration. Of the various refrigerants available, the author gives special attention to anhydrous ammonia and carbonic acid gas, concluding with a brief review of ammonia absorption and compression systems.

Crude methods of artificial refrigeration were employed in Greece as far back as the time of Aristotle. In Rome, during the reign of Nero, the rapid evaporation of warm water was a means of cooling. Ice did not come into general use until the beginning of the nineteenth century, when natural ice from New England began to be an important article of commerce.

The first attempts at producing artificial cold were by means of freezing mixtures, such as common salt mixed with snow or natural ice. Other mixtures have been employed experimentally.

The first machine for the manufacture of ice was invented in 1775 by Dr. William Cullen, based on the principle that the creation of a vacuum increases the evaporation of water, by this means producing ice. About 1810, the chemical affinity of H_2SO_4 for water was discovered. In Sir John Leslie's apparatus the substance to be frozen was placed above a vessel of H_2SO_4 in a vacuum.

In 1834, patents were granted to Mr. Perkins, an American residing in London, for an ether evaporator, surrounded by pipes through which brine was circulated. Boxes containing water were placed in a receptacle into which flowed the brine at a temperature low enough to freeze the water. The brine was then pumped back and after having been exposed again to the ether it could be used over. A temperature of five degrees Fahrenheit could be maintained. A machine operated in Cleveland, O., continuously, from 1855 to 1857, produced over 1600 pounds of ice in twenty-four hours. A machine exhibited in London in 1858 and later taken to Australia consisted of an air-tight metallic cylinder from which air was removed by a pump and in which ether was kept continually evaporating; another kept continually evaporating; another similar vessel, in which ether removed from the former was condensed under pressure, and a pump to withdraw ether from the first vessel and force it into the second. As the pressure increased, the ether assumed a liquid state ready to be evaporated; thus the process was continuous with very small losses. The first vessel was surrounded by the water to be frozen, the second by the condensing water. A 10-horsepower engine was the motor and it was claimed that one ton of coal would manufacture four tons of ice.

The immediate forerunner of the ammonia absorption system was a machine introduced about 1860 by Ferdinand Carré, a Frenchman. It was by means of this machine that the trade in frozen meat was introduced, and that ice-making first attained prominence in the United States. The necessity of distilling the water to make clear ice was realized in 1868.

In 1870, the subject of refrigeration was investigated by Professor Linde, of Munich, who was the first to consider the question from a purely thermodynamic point of view. He showed that the compression-vapor machine reached the theoretical maximum more nearly than any other. He also examined the physical properties of various liquids. In 1873 he built his first ammonia-compression machine and since then this type has been in most general use.

The first ice plant of any importance in the United States was built at New Orleans in 1866. In 1870 there were four concerns actively engaged in the manufacture of ice for sale. In 1900 this number had increased to about 800, involving capital aggregating about $40,000,000. At no time has there been a decrease in the number engaged in the industry.

Applications

There is a great field for the practical application of artificial refrigeration; by no means all of the possibilities have yet been developed. There are practical applications in scientific research, medical practice, manufacturing and commerce.

One of the first applications was in 1861, when an ether machine was used for the extraction of solid paraffin from shale oil. Perhaps the most extensive application is the preservation of meat and other perishable food articles in "cold storage." This makes possible the transportation of perishables to great distances. In the same way fish eggs have been kept at the proper temperature during transportation through varying climates. Flowers can be kept nicely in cold storage. The manufacture of artificial ice is another extensive application.

Artificial refrigeration makes possible the operation of breweries and chocolate factories in all climates during all the months of the year. In cities there are central refrigerating plants from which the refrigerating agent is distributed through extensive pipe lines to cold-storage room or to any other place where there is a demand.

For cooling the water in city mains or on a smaller scale in the drinking supply of buildings, for regulating the temperature in hospital wards, for preserving in glass cases human bodies which have to be left out in morgues for identification —these and many other applications have proved to be practical.

In 1885, a Swedish engineer encountered a quicksand in the construction of a tunnel through a hill on which there were buildings. He successfully froze the ground and completed the tunnel without any damage to the foundations above.

Freezing Mixtures

One pound of ice takes up 144 B.t.u. in melting. One part of NaCl to 2 parts of ice will produce temperature of —5 degrees Fahrenheit. Five parts of NaCl to 12 parts of ice to 5 parts of NH_4NO_3 will produce —25 degrees Fahrenheit. Three parts of snow to 4 parts of K_2CO_3 will produce —51 degrees Fahrenheit. Fifty-nine parts of tin, 103 parts of lead and 183 parts of bismuth, melted together, cooled, powdered and quickly stirred with 108 parts of mercury will produce 0 degree Fahrenheit. Other freezing mixtures are solid carbonic acid and sulphuric ether, and sulphate of soda and hydrochloric acid. These freezing mixtures are useful on a small scale; the most of them are practical only in the laboratory. The temperatures given are theoretical.

Good Refrigerants

The essential qualities are: Low boiling point; high latent heat of vaporization. A number of substances have been employed with varying success: "Pictet liquid," sulphuric ether, ethyl chloride, methyl chloride, sulphur dioxide, air, carbonic anhydride, anhydrous ammonia. There are conflicting theories about Pictet liquid, a mixture of carbonic acid and sulphuric acid. The system has never been in general use. Ethyl chloride machines are used for small work only. Ether machines were formerly in great favor but have been abandoned because of the enormous size of the compressor required and the great inflammability of the ether.

Sulphur dioxide requires great compressor capacity and gives low efficiency. Air machines are comparatively bulky. There must be a large clearance in the compressor. Many minor circumstances combine to cut down the efficiency, so that the actual is much below the theoretical. Compact designs of limited capacity are in use to some extent on shipboard more than elsewhere, because of the harmlessness and availability of the medium.

The two most efficient refrigerants and

the only ones worthy of much consideration from a practical standpoint are anhydrous ammonia (NH_3) and carbonic anhydride (carbonic-acid gas, CO_2).

The accompanying tables, taken from *The Engineer*, give an interesting comparison of the refrigerating values of various substances.

HEAT VALUE AND BOILING POINT.

Substance.	Boiling Point, in ° F.	Latent Heat, B.t.u.	Specific Heat.
Water	212	966	1.0
Alcohol	173		
Chloroform	140		
Sulphur Dioxide (SO_2)	14	168.7	0.41
Ether	— 10		
Au. Ammonia (NH_3)	— 28.5	573	1.0058
Carbon Dioxide (CO_2)	—140	141	0.955

Carbonic-acid Gas

Anhydrides are formed by taking from certain acids oxygen and hydrogen in the proportion that forms water; thus $H_2CO_3 - H_2O = CO_2$. "Anhydrous" means without water.

CO_2 has certain advantages over NH_3: It does not decompose under any conditions, is harmless when it escapes, is easy to manufacture and therefore cheap, costing not over 8 cents a pound. CO_2 does not corrode brass or copper; it is 32.4 times heavier than NH_3 and the relative efficiency by volume is 7 to 1. This makes the machinery very compact and especially adaptable to marine service. The cylinder volume is one-sixth that of the NH_3 compressor and one-fifteenth of the SO_2 compressor. The boiling point is very low. There is no danger of frosting too near the compressor, thereby freezing the packing and causing leaks; the compressor can be covered with frost without reaching the freezing point of CO_2. NH_3 mixed with impurities is combustible, while CO_2 is a fire extinguisher.

CO_2 has disadvantages which account for the more general use of NH_3. The latent heat is low and the condensing pressure very high, from 50 to 75 atmospheres. At 60 degrees Fahrenheit the pressure is 684 pounds per square inch absolute, with the back pressure in the system about 350 pounds per square inch. It is obviously quite difficult to build machinery that will carry this high pressure. At 0 degree Fahrenheit the latent heat of CO_2 is only 123 B.t.u., while that of NH_3 is 555 B.t.u.; CO_2 will not liquefy below 88 degrees Fahrenheit, so it is not efficient when comparatively cool condensing water is not available. The small cylinder volume makes clearance loss greater.

Anhydrous Ammonia

Ammonia is an important byproduct in the manufacture of illuminating gas or coke. It can be made in many ways but this is perhaps the most usual method.

When the crude illuminating gas is passed through the "scrubber" the water absorbs the ammonia, forming "gas liquor," containing about 2 per cent. of NH_3, and numerous impurities. Purification is accomplished by making a salt of ammonia and subsequently driving off NH_3 from a solution of the salt. The usual method is to expose the "gas liquor" to steam, which carries off the NH_3; then introduce "milk of lime," which liberates the fixed ammonia, which in turn goes up with the steam to a vessel containing H_2SO_4. The acid combines with NH_3, precipitating $(NH_4)_2\,SO_4$ odorless crystals containing 25 per cent. of NH_3. A solution of this salt exposed to "milk of lime" liberates NH_3 which, after a further purifying and drying process, is compressed to liquefaction and placed in metallic drums under pressure for distribution.

NH_3 is valuable as a refrigerant because of its low boiling point, its high latent heat of vaporization and its noncorrosive effect on iron and steel. (See the tables.) It becomes a liquid at a temperature of —40 degrees Fahrenheit atmospheric pressure, or at 100 pounds per square inch normal temperature. One cubic foot of liquid NH_3 weighs 39.75 pounds.

One volume of H_2O at 32 degrees Fahrenheit absorbs 1050 volumes of NH_3; at 50 degrees, 813 volumes; at 59 degrees, 727 volumes; at 68 degrees, 654 volumes.

In the use of NH_3 for refrigeration there are two systems, known as the compression system and the absorption system. In either, there are two main parts: The liquefying apparatus, where the gas is liquefied; the heat-absorbing or refrigerating apparatus.

COMPARATIVE QUALITIES OF GASES.

Substance.	Absolute pressure in pounds per square inch at 0° F.	Heat of vaporization per pound at 0° F. (old data).	Heat of vaporization per pound at 0° F. (Lorenz).	Volume in cubic feet per pound at 0° F. (old data).	Volume in cubic feet per pound at 0° F. (Lorenz-Stetefeld).	Specific heat of the liquid (old data).	Specific heat of the liquid (Mollier-Lorenz-Stetefeld).	Heat of vaporization per cubic feet (old data).	Heat of vaporization per cubic feet at 14° F. (Stetefeld).	Loss in per cent. due to cooling the liquid (Lorenz-Stetefeld).	Useful heat of vaporization per cubic foot compressor volume (Lorenz-Stetefeld).	Volume in cubic feet per pound at 14° F. (Stetefeld).	Loss in per cent., due to clearance friction and leakage (Stetefeld).
CO_2	310	123.2	115	0.27	0.3	1.00	0.79	444.7	483.5	17	400	0.44	19
SO_2	10	171.2	161	7.35	7.4	0.41	0.277	23.3	32	5	28	5.3	43
NH_3	30	555.5	588	9.10	9.5	1.02	1.153	61.7	83.7	4.5	80	7.0	42

The Compression Cycle

It will now be well to outline the cycle of events in the compression system, which is the system now in use and applicable to both substances.

The essential parts of the system and their functions are: A compressor, which reduces the volume of the gas and increases its temperature by changing work into heat; a condenser, in which the heat imparted to the gas is given up to cooling water, thereby liquefying the gas; and an evaporator, in which the liquid is made to boil, absorbing heat from the surrounding media and changing into the gaseous condition. This cycle applies to all the vapor-compression machines, with a varying of the volumes, pressures and temperatures as shown in one of the tables.

Ammonia Absorption and Compression Systems

In the absorption system in actual operation, there are the following parts: A steam-heated generator containing aqua ammonia, an analyzer where ascending ammonia gas is enriched by the incoming strong liquor, a rectifier where water vapor is separated from ammonia by distillation, a condenser and liquid-ammonia receiver, an expansion valve, an expansion coil, an absorber, a strong-liquor pump, an exchanger where outgoing weak liquor heats the incoming strong liquor.

After expansion, the gas enters the absorber, a steel shell containing coils through which cooling water flows. As the gas comes in contact with the weak-liquor spray, which also enters the absorber, it is absorbed, converting the poor

COMPARATIVE REFRIGERATIVE VALUES.

Substance.	Theoretical compressor volume required at 14° F. per ton per minute in cubic feet.	Loss due to radiation in refrigerator brine system.	Loss due to clearance in per cent.	Loss due to friction in suction pipes and valves in per cent.	Loss due to leakage of piston and valves in per cent.	Total loss, in per cent.	Actual required compressor volume at 14° F. per ton per minute in cubic feet.	Compressor volume usually allowed in practice per ton per minute in cubic feet.	Theoretical efficiency per 1 horsepower in B.t.u.	Practical efficiency per 1 horsepower in B.t.u.
CO_2	0.49	6	5	4	9	24	0.60	0.61	14.855	13,370
SO_2	7.04	6	6	14	23	49	10.566	10.6	16.673	13,300
NH_3	2.4	6	6	11	25	48	3.56	4.0	16.673	13,300

into rich liquor. In absorbing the gas work is done and the heat produced must be carried away by the cooling water.

The exchanger is a cast-iron shell with iron coils on the inside. The strong liquor from the absorber and the weak liquor from the generator enter the exchanger from opposite directions, the heat from the weak liquor being given up to the cool strong liquor. This makes it easier for the latter to part with its gas in the analyzer and for the former to absorb fresh gas in the absorber. The strong liquor has to be pumped into the exchanger. From the exchanger the strong liquor passes to the analyzer, a cast-iron shell mounted vertically over the generator and containing trays over which the rich liquor trickles downward.

The generator is a horizontal cast-iron shell provided with steam coils for heating the contained ammonia liquor. The vapor from the generator passes up through the analyzer, where it is enriched by the gas from the rich liquor. It then passes to the rectifier, coils over which cool water is flowing, where the entrained water is condensed and returned to the generator without liquefying the gas.

The condenser acts also as a liquid receiver. It is a heavy cast-iron shell with interior spiral coils through which the cooling water flows. The gas from the rectifier enters the shell at the top and owing to the pressure and lowered temperature is liquefied. The lower part of the shell serves as the receiver.

From the receiver the liquid ammonia passes on to the expansion valve, through which it expands, changing back to the gaseous state and circulating in the brine cooler, direct-expansion coils or whatever form of cooler may be employed. After expansion, the cycle just described is repeated.

In testing the distilled water for the absorption system advantage is taken of the fact that most waters contain chlorides or sulphates. The addition of $AgNO_3$ solution, or $BaCl_2$, will therefore cause a white precipitate in warm water that has been imperfectly distilled.

A sample of "poor liquor," from somewhere between the generator and absorber, and a sample of "rich liquor," from the absorber, should show the rich liquor containing 14 per cent. more ammonia than the poor liquor—this amount having been taken up in the absorber. The standard for rich liquor is 26 degrees Baumé, containing 28 per cent. of pure NH_3; the standard for poor liquor is 18 degrees Baumé, containing 14 per cent. of pure NH_3.

The high back pressure in the absorption system makes it desirable for long ammonia refrigerating lines. Except in very large installations, the absorption still can be operated by exhaust steam. There are operating difficulties which make the absorption system less desirable than the compression system; these difficulties combine to cut down the efficiency. The pump is hard to regulate. Water vapor entrained with the ammonia gas brings about a direct loss. The necessity of frequently blowing out the pipes is a source of trouble.

A writer in *The Engineer* suggests that an absorption plant could be run to advantage in connection with a compression plant by using the compressor exhaust in the absorption still. In a 100-ton ice plant made up of a 68-ton absorption machine and a 32-ton compressor, driven by a simple Corliss engine at 100 pounds steam per square inch, with 1 pound back pressure, using 29 pounds of steam per horsepower-hour, it would be possible to increase the economy enough to make more than 17 tons of ice per ton of coal.

After expansion in the refrigerating coils at a pressure of from 0 to 30 pounds the gas is sucked into the compressor and discharged at a higher pressure of from 125 to 180 pounds, depending upon the temperature of the cooling water of the condenser. In the condenser, owing to the pressure and lowered temperature, the gas is liquefied, thereby being reduced in volume, making room for more gas without an increase in pressure. Between the compressor and the condenser is the oil trap, a cylinder which the gas enters at the side, usually, impinging upon the opposite side and baffle plates upon which is deposited the oil brought from the cylinder where it was necessary for lubrication; the gas free from oil then passes out at the top.

There are several types of condenser, in all of which flowing water is used to cool the compressed gas to a point of liquefaction. The common types consist of either vertical coils mounted horizontally one above the other with water trickling over them or entirely submerged or a series of double-tube coils, one pipe within another, arranged so that the ammonia is circulated downward through the outer and larger pipes, while the cooling water is circulated in the opposite direction through the inner pipes. From the condenser the liquid goes into the liquid-ammonia receiver, whence it goes out again through the expansion valve into the coils, repeating the cycle. The receiver is a cast-iron or steel cylinder of varying proportions, sometimes large enough to hold the entire refrigerating charge. The expansion valve is of the needle type, which permits of delicate adjustment. Another type is a cock with an acute V-shaped opening; it is often provided with a worm and worm wheel so it can be adjusted accurately.

All parts and fittings that come in contact with ammonia must be of iron or steel, because of the noncorrosive effect of the gas on iron.

There are two systems of refrigeration, the direct-expansion system and the brine system. In the former the ammonia is circulated through coils to cool by direct radiation; in the latter it is used to cool brine which is circulated through the refrigerating coils.

There are two methods of operating a compressor, the wet and the dry. In the wet method, the ammonia is allowed to evaporate only to such a point as to allow small particles of wet ammonia to be carried back to the compressor. These particles absorb part of the heat developed in compression and keep the compressor temperature down. A water jacket is unnecessary with this method; the back pressure can be higher, giving greater density in the refrigerating pipes and therefore a higher efficiency so the refrigerating surface can be reduced. In a cool cylinder more vapor can be compressed and the oil will not be decomposed. The amount of ammonia necessary in the system can be regulated easily by observing the temperature of the cylinder.

The dry method is theoretically correct, allowing the gas to take up as much heat as possible. This, however, makes necessary a greater refrigerating surface. The cylinder, although water-jacketed, becomes highly heated inside, decomposing the oil. The heated parts expand, allowing a smaller amount of vapor to be compressed. Clearance between piston and cylinder head is a serious source of loss.

The German imperial navy has recently received the addition to its active list of a destroyer, equipped with Zoelly turbines. According to *The Engineer*, this destroyer was built for a contract speed of 30 knots, and has two main turbines, each of 7500 horsepower at 650 revolutions per minute. The boat has a displacement of about 650 tons, and its length is about 350 feet. The speed during the three hours' trial was nearly 32 knots, while the maximum speed attained in Eckenförder bay, near Kiel, was 33⅓ knots. The turbines, it is reported, ran perfectly during all the trials, viz., both in the workshops and after being fitted in the destroyer, and have not given rise to the least interruption.

The trial readings gave the following results: Pressure at turbine, 14.85 atmospheres; vacuum, 89.95 per cent.; revolutions, 643.9 per minute; slip, 23.4 per cent.; average speed, 30.757 knots; steam consumption, 14.2 pounds. The exhaust from the auxiliary machines is not passed into the low-pressure stages of the turbine. Had this steam been so dealt with the foregoing results in comparison with figures from other official trials would have been considerably modified.

Explosion of a Stop Valve Chest

The accident was due to water hammer set up by the turning of live steam into a cold and improperly drained steam-pipe range.

In November of last year, at the Londonderry Corporation electric supply station, there occurred an explosion of a stop-valve chest, scalding the fireman and fracturing the chest to such an extent that only its lower neck containing the valve seat and the flange to the branch steam pipe remained in position, as shown at *B*, Fig. 1.

The valve was of the type shown at *A*, Fig. 1, with chest and cover made of cast iron and the valve, valve seat, spindle and gland of brass. The thickness of the metal in the body of the chest and its two branches was 13/16 inch. There was no drain fitted to the valve chest.

The general arrangement of the piping in the plant is shown in Fig. 2.

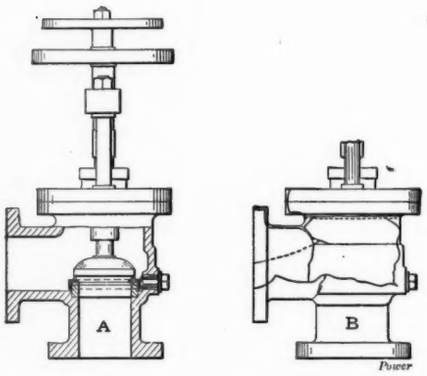


FIG. 1. SHOWING TYPE OF VALVE

According to the report of the British Board of Trade, it appears that there was no steam in boiler No. 5 on the day of the explosion; and, as it was a Sunday, the other boilers had been shut off from the steam-pipe range that morning by closing their stop valves. All the drains in the main steam-pipe range were fully open.

About 3 p.m. the fireman, preparatory to starting the engines for lighting the town, began to raise steam in No. 2 boiler, leaving the others with their fires banked. When there was 120 pounds of steam in No. 2, he opened the stop valve with the intention of heating up the steam-pipe range. A few minutes after doing this he opened the stop valve on No. 5 (the one in which there was no steam), thinking that by so doing he would be able to clear the whole pipe range of any water that might be lying in it. Immediately upon opening this valve the explosion occurred.

It is supposed that a large amount of condensation took place as soon as the stop valve on No. 2 boiler was opened to the cool steam-pipe range and that the drains to the pockets, although open, were not in the right position to thoroughly and quickly clear the range of water. The partial opening of the stop valve on No. 5 boiler, situated at the extreme end of the range, no doubt set the water in the pipes, in motion. This produced further condensation, thereby increasing the quantity of water and at the same time accelerating its velocity until it had sufficient force to break the valve chest.

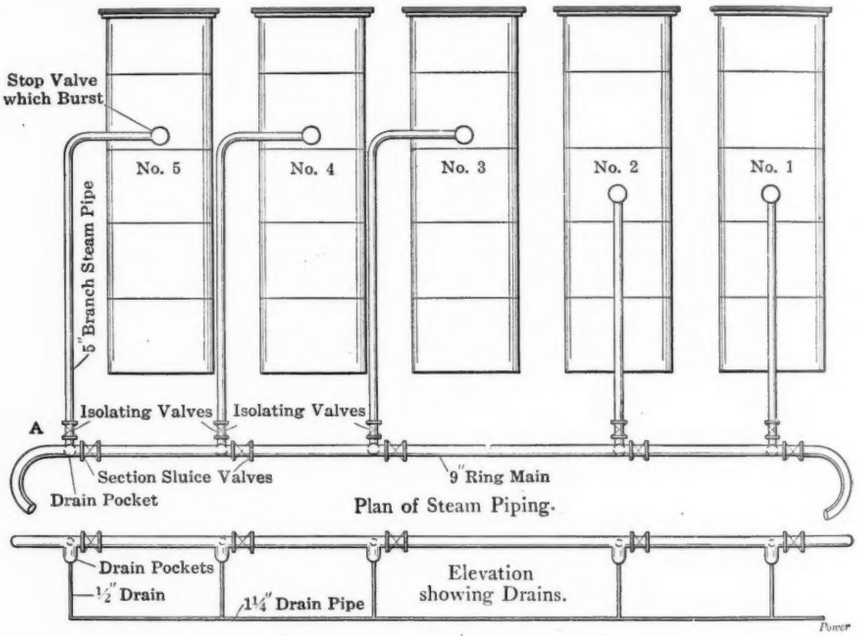


FIG. 2. GENERAL ARRANGEMENT OF PIPING

Equivalent Boiler Performance

A reader asks for the explanation in "plain English" of the following problem:

A boiler is sold on a guarantee that it will evaporate 12 pounds of water per pound of combustible from and at 212 degrees with coal having a heat value of 14,500 B.t.u. per pound of coal and 8 per cent. ash.

When the test was made the average feed-water temperature was 180 degrees, average steam pressure 70 pounds, heat value of coal 12,000 B.t.u. per pound with 8 per cent. ash; water evaporated, 9 pounds per pound of coal. How does the test compare with the guarantee?

Under the conditions of the guarantee the coal is 0.08 ash and

$$1 - 0.08 = 0.92$$

combustible.

1. If one pound of coal contains 14,500 B.t.u., one pound of combustible will contain

$$\frac{14,500}{0.92} = 15,760 \text{ } B.t.u.$$

2. With this your boilermaker agrees to evaporate 12 pounds of water from and at 212 degrees, or one pound under those conditions for each

$$\frac{15,760}{12} = 1313 \text{ } B.t.u. \text{ } supplied.$$

3. The temperature corresponding to 85 pounds absolute (70 pounds gage prox.) is 316.3.*

	B.t.u.
To raise a pound of water from 32 to 316.3 degrees requires.....	286.30*
To raise a pound of water from 32 to 180 degrees requires.....	147.88*
To raise a pound of water from 180 to 316.3 degrees requires.....	138.42
To evaporate a pound of water from and at 316.3 degrees requires.....	897.10*
To raise a pound of water from 180 to 316.3 degrees, and evaporate it at 85 pounds absolute requires....	1035.52

*The quantities marked with asterisks are from the new steam tables of Marks & Davis.

4. To evaporate a pound of water from and at 212 degrees requires 970.4* B.t.u. A pound of water evaporated under the test conditions is equivalent then to

$$\frac{1035.52}{970.4} = 1.067$$

pounds evaporated from and at 212 degrees.

5. The evaporation of nine pounds under the test conditions was, therefore, equal to

$$9 \times 1.067 = 9.603$$

pounds from and at 212 degrees.

6. This was done per pound of coal with 12,000 B.t.u. The heat per pound of water evaporated on the test, made equivalent to the evaporation from and at 212, is

$$\frac{12,000}{9.603} = 1250 \text{ } B.t.u.,$$

which is less than the boilers were allowed by the guarantee.

To evaporate 12 pounds of water from and at 212 (see paragraph 4) would require

$$12 \times 970.4 = 11,644.8 \text{ } B.t.u.$$

Since the boiler has by the guarantee 15,760 B.t.u. (see paragraph 1) to do this with, it must have an efficiency of

$$\frac{11,644.8 \times 100}{15,760} = 73.9 \text{ } per \text{ } cent.$$

To evaporate nine pounds from 180 at 70 pounds gage (316.3 degrees Fahrenheit) requires (see paragraph 3)

$$9 \times 1035.52 = 9319.68 \text{ } B.t.u.$$

Since the boiler had 12,000 B.t.u. to do this with, its efficiency on test was

$$\frac{9319.68 \times 100}{12,000} = 77.66 \text{ } per \text{ } cent.,$$

which is better than the guarantee.

The evaporation of

$$\frac{12,000 \times 0.739}{1035.52} = 8.564$$

pounds under the test conditions would have been equivalent to the guarantee in accomplishment per heat unit furnished, because it was agreed to put into the steam only 0.739 of the heat in the coal, and it takes 1035.52 B.t.u. to evaporate a pound under the test conditions (paragraph 3); 8.564 pounds under test conditions equals pounds from and at 212 (paragraph 4), and 9.137788 pounds with 12,000 B.t.u. equals

$$8.564 \times 1.067 = 9.137788$$

$$\frac{9.137788 \times 15,760}{12,000} = 12$$

pounds with the 15,760 B.t.u. allowed by the guarantee.

Corrosion of Iron and Steel

The theory of corrosion was explained by George K. Elliott, chemist for the Lunkenheimer Company, in a talk before the National Association of Stationary Engineers association No. 28, of Chicago, Saturday evening, April 16. Mr. Elliott said that there were two generally accepted theories of corrosion, the first and oldest of which was known as the carbon-dioxide theory. According to this theory the CO_2 present in a feed water unites with the water, H_2O, and forms carbonic acid, according to the reaction

$$CO_2 + H_2O = H_2CO_3.$$

As all acids have the property of attacking metals the iron unites with the acid-forming bicarbonate of iron, $FeHCO_3$, which is soluble in water. Oxygen, which is always present to a greater or less degree in water, then completes the reaction by combining with the soluble bicarbonate of iron, forming ferric oxide, which is insoluble. This reaction frees the CO_2, which then combines with the water to form more carbonic acid, and the process is repeated.

This theory, it was explained, was popular until investigators found that pure iron would corrode to some extent in pure water containing no oxygen, and a new theory called the electrolytic theory was then developed and is now accepted as the more modern explanation of the phenomenon.

According to this later theory every metal in water has a tendency to go into solution to some extent and the measure of this tendency is called its solution pressure. The metal sodium is an illustration of the solubility of metals in water, as it has an extremely high solution pressure and immediately dissolves in water with the evolution of heat. At the other extreme are metals like platinum and gold with small solution pressures, and between these two extremes are the common metals, copper, tin, lead, zinc, etc.

According to the electrolytic theory, anything in solution forms ions, with positive and negative charges. When iron is placed in water the positive hydrogen ion plates the surface of the iron, leaving the negative OH ions free in the solution, and the corrosion will continue until the solution pressure of the iron is neutralized by being heavily covered with a coating of hydrogen bubbles. This action of hydrogen on the iron polarizes the solution and the action stops. If, however, free oxygen is present in the water it unites with the free hydrogen being formed on the iron surface, forming water, depolarizing the solution, and the action is therefore continued. The more hydrogen ions in solution the more iron will go into solution. The less hydrogen ions in solution, the less the iron will dissolve. Acids contain the greatest number of hydrogen ions and therefore have the greatest corrosive action.

The action of corrosion on iron and steel samples was illustrated by taking advantage of the fact that potassium ferri cyanide in the presence of iron turns blue, and that phenol-thaline in the presence of OH ions turns pink. The reactions were isolated by thickening the solutions in which they occurred with gelatin so that the different colors could be seen.

It was shown that if platinum, which has a less solution pressure than iron, was attached to an iron plate, corrosion of the iron would be much more rapid on account of the positive hydrogen ions attaching themselves to the platinum, leaving the iron exposed to corrosive action. On the other hand, if a metal like zinc were attached to an iron plate, the zinc having a higher solution pressure would go into solution and the iron would be protected by the positive hydrogen ions. Black scale, it was said, had a similar action to platinum, and hurries the corrosion of the iron, which shows its undesirability in boiler plate. Anything which will cut down the hydrogen ions in solution will decrease corrosive action. In practice this is done by adding hydroxyl, or OH ions. Hydroxyl ions come in the form of caustic soda, which is a familiar substance to boiler users.

Another way to decrease corrosive action, it was explained, was to remove the free oxygen from the feed water so that the corrosive action would soon become polarized. Four ways of doing this were suggested. First, by using an open feed-water heater and driving out the oxygen by the aid of heat. Second, by attaching the dry-vacuum pump to the heater, thus removing the oxygen. Third, by drawing the feed water through scrap iron so that the corrosive action of the free oxygen would be over before the water reached the boiler. Fourth, by adding an alkaline tannic solution, which has the property of combining with the free oxygen.

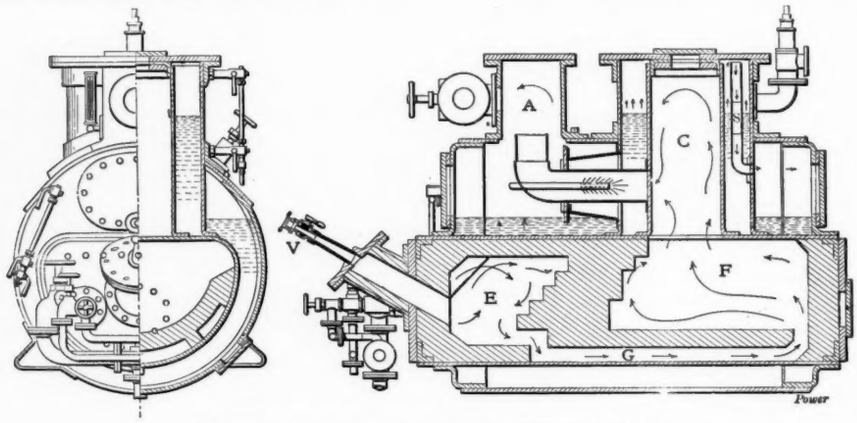
Another familiar method is to attach zinc plates to the boiler. Aluminum and magnesium will also have the same action as zinc. It was explained, however, that the zone of protection in the case of zinc plates was quite limited, and if any considerable area was to be protected a number of plates would have to be used.

Oxidation produces electrolytic action

and the presence of any impurities hastens the action. The most common impurities found in iron and steel were given as graphite, manganese sulphide and phosphorus. Difference in mechanical structure, it was explained, would also cause a corrosive action. This is the reason why it is common practice to specify that in boiler plate, holes must be drilled and not punched, as the metal surrounding punched holes is strained and corrosive action is more liable to occur. Grooving was explained by the statement that grooves marked the line of mechanical strains in the plates in which corrosive action was set up due to its difference in structure. Among other aids to corrosion were cited impurities in the water, such as sulphur in mine water, and vegetable and animal matter, humic and tannic acids, in water from swampy regions. At the conclusion of the talk there followed a number of interesting lantern slides showing microphotographs of different samples of iron and steel containing various degrees of impurities.

Combining Steam and Furnace Gases

Several inventors are working upon methods whereby the products of combustion instead of going off up the stack and carrying away from 20 per cent. upward of the heat due to combustion are made to join the steam and work in the engine. In order to do this, of course, the combustion has to take place under pressure. The Schmidt system, which is in actual operation on a Russian torpedo boat, is shown by the accompanying engraving and described as follows:



SCHMIDT SYSTEM FOR RUSSIAN TORPEDO BOAT

In the illustration *V* is the tube through which the furnace may be inspected, *E* is a chamber lined with firebrick in which the combustion takes place, *G* and *F* are passages in which the temperature varies between 1800 and 2000 degrees Centigrade, *C* is a dome in which the temperature is 1200 degrees Centigrade and is surrounded by water, the steam from which escapes through the pipe *S*. The products of combustion pass out through a conduit into which water is injected through a perforated pipe, which cools the gases sufficiently to make the temperature of the final mixture between 350 and 500 degrees Centigrade. The advantages are absence of chimney, no hot gases to void and the losses limited only to the radiation through the walls of the boiler. In marine work sea water could even be employed, as there is no metal which is at the same time in contact with fire and water and under an unbalanced pressure.

We are indebted to *La Technique Moderne* for the drawings reproduced herewith.

Superheat for Marine Engines

Some comparative tests have recently been made as to the effect of superheating on the economy of marine engines as fitted to an American steam yacht, the "Idalia." The results are striking: With 105 degrees Fahrenheit of superheat the water consumption was reduced by 15 per cent. as compared with the consumption with saturated steam. The "Idalia" is 178 feet long over all, and 140 feet on the water line, 20 feet beam, 10 feet deep, with a draft of 9 feet, and has a gross tonnage of 201 tons. The propelling machinery is of the four-cylinder triple-expansion type, the cylinders being respectively 11½x19x22 11/16x 22 11/16 inches diameter and 18 inches stroke, with piston valves on all four cylinders. The steam supply is from a Babcock & Wilcox boiler, using anthracite coal, with 65 square feet of fire-bar surface, with 2500 square feet of heating surface. The superheater, which is of the Babcock & Wilcox type, has a heating surface of 340 square feet. All the auxiliary engines, except the dynamo engines, take superheated steam at full boiler pressure. The trials were made under conditions that were practically identical, so far as their effect on the result was concerned, the main engines and auxiliaries being run at nearly constant speeds. The temperatures and pressures were recorded at intervals of 15 minutes, and frequent sets of indicator diagrams were taken.

SUMMARY OF TESTS.

	Saturated.	Superheat, 57 Deg.	Superheat, 88 Deg.	Superheat, 96 Deg.	Superheat, 105 Deg.
Pressures:					
Throttle	190	196	201	198	203
First receiver	68.4	66	64.3	61.9	63
Second receiver	9.7	9.2	8.7	7.8	8.4
Vacuum	25.5	25.9	25.9	25.4	25.2
Temperature:					
Feed	201	206	205	202	200
Hotwell	116	109.5	115	111.5	111
Revolutions per minute:					
Air pump	57	56	53	54	45
Circulating pump	196	198	196	198	197
Main engine	194.3	191.5	195.1	191.5	193.1
Main engine—indicated horsepower	512.3	495.2	521.1	498.3	502.2
Water per hour—total	9,397	8,430	8,234	7,902	7,790
Water per indicated horse power	18.3	17	15.8	15.8	15.5
Saving of steam—per cent	.....	7.10	13.66	13.66	15.30

The main results are set out in the appended table. The trial with saturated steam was of 2½ hours' duration; with superheated steam at 57 degrees, of two hours' duration; at 88 degrees, of three hours; at 96 degrees, of 2½ hours, and of 105 degrees, of three hours' duration.

It will be noted that the water consumption of the engines with the saturated steam was 18.3 pounds per horsepower-hour, which was reduced to 17 pounds with steam at 57 degrees superheat, to 15.8 pounds with steam at 96 degrees superheat, and to 15.5 pounds with steam at 105 degrees superheat.—*Engineering.*

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Power and The Engineer

Editorial

College Graduates

It has become the fashion of late to criticize the graduates of our colleges, especially our engineering colleges, and to show how they fail to meet the demands made upon them. Much of this criticism is unreasonable, some of it is even peevish, but no doubt the greater part of it is well meant.

In the good old days of the literary and classical college, much practical knowledge or experience was not expected of the graduate; he was intended to be more or less of an ornament to society and to adorn the pulpit or the teacher's chair. If he was only sound in his orthodoxy and could read Latin and Greek, his deficiencies were forgiven.

The doctor and the lawyer for the most part learned their professions in the offices of their elders and in active practice. The engineer grew up in the factory or on the road and learned his trade by hard knocks.

In the family of two or twelve children only the oldest son was destined for college, or if he balked at the preferment, then the next in order.

It was with the Morrill Act, endowing with Government land "Colleges of Agriculture and the Mechanic Arts" and the acceptance of the trust by numerous States, that a new order of things began. A college education seemed within the range of an ordinary income and what was more important, seemed to point the way to remunerative employment outside the learned professions.

With the growth of labor unions and the restrictions imposed by them on the employment of apprentices, one avenue of practical training was closed. But in 1876, an exhibit at the Centennial Exposition in Philadelphia, of work done by students of the Russian Imperial School at Moscow, opened the eyes of our educators to the possibility of combining manual and mental training in college.

Beginning at the Massachusetts Institute of Technology in Boston and spreading from there to Maine, Cornell, Ohio, Purdue, Illinois and so on, college shops were opened and college boys were taught to saw and hammer, to turn and plane in wood and metal. The exercises then were elementary and crude and it is a far cry from the shops at that day to the practical equipment of our modern State universities and private technical schools.

Elementary manual training is now taught in high school rather than in college, while the latter has turned its attention to the higher problems of manufacturing. The recent development of engineering laboratories and the providing of facilities for solving technical problems by careful experiment rather than by mathematics alone is a still more important step.

But with all these improvements and advantages, it should be remembered that there are yet many things which cannot well be taught in college. Is it not possible that we are expecting too much of our colleges? If a college, technical or otherwise, gives its student a fair liberal education on general subjects and a training in the fundamental principles underlying his chosen profession, is this not all that it should try to do? In the words of one eminent engineer, "The technical school should teach only those things which the student cannot readily learn outside."

Engineering graduates are criticized because they are deficient in knowledge of practical details; it is certain that they know far more of such things than formerly. They can use wood- or iron-working tools and machines with a fair degree of skill. They know something about firing and running a boiler, something about the care and testing of steam and gas engines. They know how to start, stop or adjust electrical machinery. They can test iron, steel, brick or concrete and they are more or less familiar with the properties of materials. They also understand the principles underlying the design, construction and operation of machinery and the theory of framed structures. Is not this about all that would be expected of a young man on graduation?

It has been urged that their teachers are academic, scholastic and unfamiliar with practical problems. Whatever may have been the case formerly, this is not true today. The majority of the instructors in technical colleges are men of experience who are doing outside work in engineering and whose professional services are continually in demand. The difficulty is to keep such men from forsaking their college work on account of the greater financial inducement outside.

Undoubtedly the average graduate is apt to put rather a high valuation on himself and thus be open to criticism.

The exceptional demand of late years

for the services of technically educated men has perhaps turned the heads of some; frequently the graduate finds himself with several positions from which to choose and quite naturally attributes this fact to his superior abilities. Contact with other men and with the stern logic of material things will soon cure him of his folly. If he has the right material in him, a few years of experience will make an engineer of him and he will find himself about five years ahead of the man who has not had the advantage of a technical education.

In spite of adverse criticism, the demand for graduates is steadily increasing, so that in some sections it exceeds the supply.

If the college man does not ask too much for himself and his employer does not expect too much of him, they can meet on common ground to the advantage of both. Let the young man remember that it is not dollars but reputation which tells the story and the "old man" remember that the other is but a boy after all.

A Twisted Argument

Most salesmen of gas engines operating on the two-stroke cycle will tell you that one of the chief advantages of that kind of engine is that the explosions are not so violent as in a four-stroke engine because there are twice as many of them per revolution; therefore the engine is not racked so severely and maintenance is less expensive and troublesome. This statement is even published in the catalogs of some of the builders of two-stroke-cycle engines.

The claim is made in all sincerity and honesty, but it is not necessarily true nor is it usually vindicated in the actual engine. With similar conditions there is no reason why the explosion pressure should be lower in the cylinder of a two-stroke engine than in the other type, unless the combustion efficiency is lower. The correct comparison is this:

Assuming the same combustion efficiency, compression and fuel quality in both types, the explosion pressure in the two-stroke-cycle cylinder would be exactly the same as that in the four-stroke-cycle cylinder. Since there are twice as many explosions per revolution, however, in order to get the same indicated horsepower it is necessary to have only one-half the piston area, and this would make the total maximum pressure on the crank pin and main bearings only one-half that in the four-stroke engine. But a two-stroke engine is slightly less efficient than a four-stroke engine, and it is necessary, therefore, to make the piston area from fifty-five to sixty per cent. of the area that would be needed in a four-stroke-cycle engine to get the same *brake* horsepower with the same fuel and compression. Fifty-seven per cent. is a fair average for engines of moderate size, and on this basis the maximum pressure exerted on the reciprocating parts would be fifty-seven per cent. of that in a four-stroke engine.

This does not necessarily mean that the main and connecting-rod bearings of a four-stroke engine are subjected to greater specific stresses than those of a corresponding two-stroke engine. If the areas are increased proportionately the specific stresses will be exactly the same.

In short, the advantages of the two-stroke-cycle engine are greater simplicity of valve gear; smoother turning moment at the crank shaft, giving less angular variation in flywheel-rim velocity; lighter bearings and reciprocating parts, and better regulation, because the governor can adjust the fuel supply twice as often. If both engines are properly designed the four-stroke type has no greater "racking" or tendency to break down from the explosions than the two-stroke-cycle engine.

Keep Your Hand on Your Pocketbook

John E. Carroll, whose get-rich-quick scheme consisting of a carbonic-acid gas engine was exposed by POWER in the issue of September, 1907, is operating in Boston. *The Sunday Post* of April 17 contains a large advertisement of Auerbach-Hill & Co., underwriters, offering the stock of the Carbonic Engine Power Company for three dollars per share, par value ten, and describing the engine as being the invention of plain John Carroll. If "plain John Carroll" is the John E. Carroll who promoted the CO_2 Development Company (and we have reason outside of the identity of name and occupation to think that he is) it will be well for anyone who contemplates putting any money into his device to communicate with the district attorney at Philadelphia, where Mr. Carroll is under indictment for obtaining money under false pretenses. It would be well further to look up the high-spots, at least, of Mr. Carroll's career and to have somebody who is competent to pass upon it, investigate the engine and its possibilities before signing any checks or taking any good money out of the bank.

License Laws for Illinois

A movement is on foot to obtain a law providing for the examination and licensing of engineers in Illinois. A committee of the State Association of the National Association of Stationary Engineers has prepared a draft of a bill which will be discussed at the State convention in May.

The people who run legislatures, or rather the interests whose creatures they are, do not want this kind of legislation. In a few States it has been gotten through, and especially in Massachusetts and Ohio has proved a benefit to the employer of engineers as well as to the engineers themselves, arousing them to study, self-improvement and achievement of which the employer is the beneficiary. But the real benefit and the real reason for such legislation is the protection of the public against injury from the destructive explosion of the steam boiler and the mismanagement of power-generating machinery, which comes from placing such apparatus in the hands of men who have probed their fitness for the trust.

The State has an undoubted right to do this; it is its duty to do it, and the public, which is walking over, and working within the range of such apparatus, potent for so much injury in incompetent hands, should see that it is done.

Texts for the Grafter

A correspondent of the *Rochester Post Express* submits some scriptural texts for the politicians which can be commended with equal propriety to the prayerful consideration of a certain type of engineer.

Exodus xxiii, 8—Thou shalt take no gift: for the gift blindeth the wise, and perverteth the words of the just.

Deut. xxvii, 25—Cursed be he that taketh a bribe.

Prov. xvii, 23—A wicked man taketh a gift out of the bosom [pocket] to pervert the ways of judgment.

I. Sam. viii, 3—Samuel's sons walked not in his ways, but turned aside after lucre, and took bribes, and perverted judgment.

According to the *Coal Trade Journal*, there has been a test of Rhode Island coal in a gas producer at the works of the Minneapolis Steel and Machinery Company. Well, how did it come out?

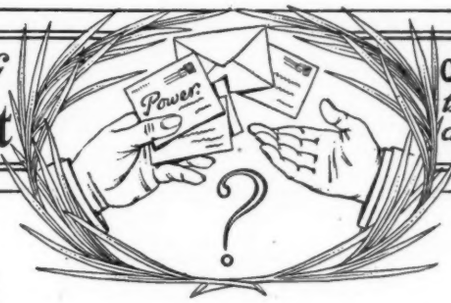
The proposed Institute of Operating Engineers offers more advantages to real engineers who came up by the way of the engine and boiler room than anything yet proposed. M. W. Rice, Engineering Societies building, 29 West Thirty-ninth street, New York, is the secretary of the provisional organization. Find out about it, and get in as a charter member.

Don't judge an engineer by his appearance. His engine is the thing to go on.

The man who knocked the manhole plate in before the boiler was free of steam was careless.

The man who recently committed suicide by climbing to the top of a smoke-stack and jumping in evidently thought he was a fit subject for combustion.

INQUIRIES of General Interest



QUESTIONS are NOT ANSWERED UNLESS they are ACCOMPANIED by the NAME and ADDRESS of the INQUIRER.

Efficiency of Boiler Seam

In a boiler seam the pitch of the rivets is 2½ inches and the strength of the joint is 72 per cent. of the sheet; would a seam with a 3-inch pitch of rivets be stronger or weaker?

J. H. M.

If the seam with 2½ inches pitch of rivets is correctly designed, the resistance of the rivets to shearing will be equal to the resistance of the plate to tearing. The efficiency of the joint is the percentage of the sheet along the outer row of rivet holes remaining after deducting the diameter of the holes. If the pitch of the rivets is increased without changing their diameter the strength of the joint will be decreased. If the change of pitch is such that a diameter of rivet cannot be chosen which will leave the percentage of uncut plate and the total shearing resistance unchanged, the joint will be weakened. If a diameter of rivet can be selected that will increase both the percentage of uncut plate and shearing resistance, the joint will be strengthened.

Factor of Safety

If you had a boiler with cast-iron heads would you figure the factor of safety from the head or from the sheet?

J. L. F.

The factor of safety is always assumed. The strength of the head and of the sheet to resist rupture should be calculated and the sums denoting this strength divided by the chosen factor of safety, the quotient in each case determining the allowable pressure.

Expressing Vacuum

Why do engineers speak of the degree of vacuum in inches and why are vacuum gages graduated to read in inches instead of pounds like steam gages?

F. E. J.

In the beginning the vacuum gage was a bent glass tube partly filled with mercury. One end of the tube was open to the atmosphere and the other connected to the condenser. When there was a vacuum in the condenser the atmospheric pressure forced the mercury up one leg of the tube a distance depending on the degree of vacuum in the condenser. The hight that the mercury rose in one leg above that in the other was measured in inches, and though the construction of the gages has changed, the old nomenclature is retained.

It would be much better for all concerned in the use of them if they were graduated to read in pounds. The reading may be readily translated into pounds, as 2.04 inches of hight of the mercury column is equivalent to one pound pressure per square inch.

Clearance and Its Effect

What is clearance and what is its effect in a steam engine?

W. E. L.

Clearance is that part of the cylinder volume not swept through by the piston and includes all of the waste space between the piston and valves. It reduces the actual ratio of expansion and increases the terminal pressure for a given cutoff or reduces the mean effective pressure for a given terminal presure. It causes loss from the free expansion of the steam in the clearance space after the opening of the exhaust valve. It increases the loss from condensation as there is a greater area to be heated by the entering steam. With the same volumetric clearance its percentage decreases as the piston stroke is lengthened.

Throw of Eccentric

If the eccentric of a slide-valve engine should be lost or destroyed, how can I find out how much throw a new one should have?

S. B. R.

The travel of the valve to give a full opening of the port must be equal to the width of both steam ports and the lap at both ends of the valve. In short, the valve travel must be two ports plus two laps. Place the valve over the ports in the center of its travel, measure the amount the valve overlaps the ports, remove the valve and measure the width of the ports; the sum of these measurements will be the distance the valve should travel and the center of the eccentric should be one-half this distance from the center of the crank shaft.

Spacing of Rivets

In laying out the rivet holes on the inside and outside courses of a boiler or smokestack, how are the rivet holes spaced? One sheet must be longer than the other but have the same number of rivet holes; how is the difference in distance determined?

F. W. J.

The mean diameter of each course is taken and the circumference is calculated from this. That is, if the inside diameter of a course of ⅜-inch plate is 72 inches, the outside diameter will be 72¾ inches, and the mean diameter will be 72⅜ inches. If the other course is to be inside this one, its outside diameter will be 72 inches and its inside diameter will be ¾ inch less or 71¼ inches, and its mean diameter will be 71⅝ inches. The circumference of the outer course will be about 227 inches and the circumference of the inner one about 225 inches. The rivet spacing will be proportional to the length of the circumferences.

Area of Segment of a Circle

Can you give me a short practical way of getting the area of the segment of a circle, such as the part of a boiler head above the tubes? I want some method of working it out without algebra or square root.

P. E. D.

The area of any surface may be found by ordinates as used in finding the area of indicator diagrams. Lay out the segment either full size or to a scale, divide the chord into any number of equal parts and draw perpendicular lines to the arc; add together the lengths of all of the perpendicular lines; multiply this sum by the length of the chord and divide the product by the number of lines. The quotient will be the approximate area of the segment in square inches. For instance suppose the length of the chord is 62 inches and there are 60 ordinates having a total length of 1100 inches, the area of the segment will be

$$\frac{62 \times 1100}{60} = 1133.3 \text{ square inches.}$$

Changing Speed of Engine

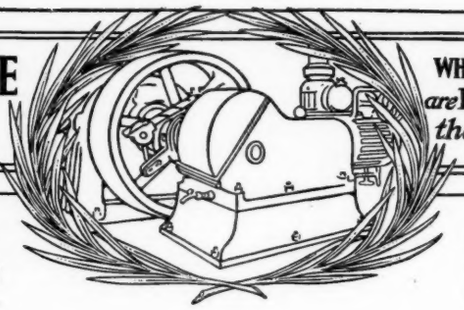
My engine runs 69 revolutions per minute and I wish to change the speed to 80 revolutions. The governor runs 63 revolutions per minute and has an 11-inch pulley. What diameter of pulley will give the proper engine speed?

M. S.

To increase the engine speed of 69 revolutions per minute to the higher speed of 80, the 11-inch pulley will have to be increased in the ratio that 69 bears to 80 or to 12.75 inches. Stated as a problem in proportion it would read

69 : 80 : : 11 : 12.75.

NEW POWER HOUSE EQUIPMENT



WHAT *the* INVENTOR *and the* MANUFACTURER *are* DOING *to* SAVE TIME *and* MONEY *in the* ENGINE ROOM *and* POWER HOUSE

The Sarco Feed Water Weigher

An apparatus for weighing the feed water supplied to a boiler has been patented and put upon the market by Sanders, Rehders & Co., Limited, 108 Fenchurch street, E. C., London, who have named it the "Sarco" feed-water weigher.

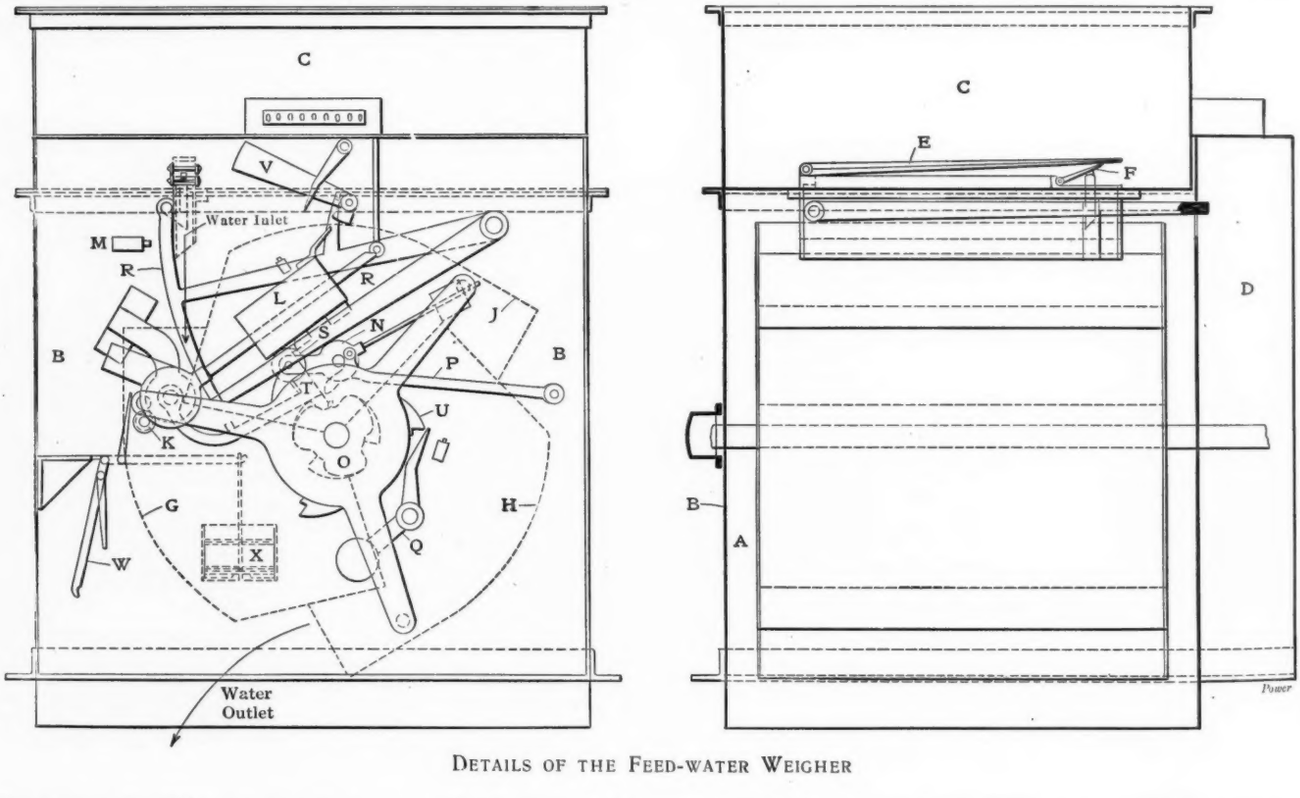
According to *The Engineer*, of London, it is claimed by its introducers to weigh all the water passing through it, to be more accurate and smaller for a given duty than any other apparatus of a similar kind, and to have no complicated working parts.

The meter comprises a drum *A*, see illustration, inclosed in a large tank *B*, a small upper or collecting tank *C*, and releasing gear which is arranged outside the meter tank proper, and is inclosed in the casing *D*. The water, which must not be under a greater pressure than that due to a 20-foot head, enters the meter through an opening in the cover of the collecting tank, and passes down into the drum tank through specially designed slot valves, shown at *E* and *F*.

The drum is divided into three compartments of equal capacity, *G*, *H* and *J*. It is mounted on a shaft which passes through the sides of the meter tank, and runs on ball bearings. The whole of the gear which controls the successive filling and emptying motions of the three compartments is arranged outside the drum tank, and cannot come in contact with the water. Mounted on an extension of the meter spindle is a head which has three arms, carrying short studs. The head is keyed upon a main shaft in such a way that each succeeding compartment of the drum is in the "filling position"—that is, with its inlet immediately below a slot valve—when the corresponding arm rests with its stud upon the roller *K*. This roller is mounted on the extreme end of the lever, which carries the weight *L*, and is pivoted on ball bearings.

In order that the drum may be released it must raise the weight *L*. This is accomplished by the action of the water itself as soon as the correct weight is contained in the chamber. Weight *L* is then momentarily thrown against the buffer *M*, the stud on the spindle glides off the roller *K*, and the chamber discharges its contents through the open bottom of the tank *B* into the suction well, or tank over which the meter has been erected. The travel of the weight is controlled by the balanced lever *N*, the end of which is provided with a roller. This lever is actuated by projections of the cam *O* through the medium of the fork *P*. A pneumatic buffer takes up the rebound of the weight *L* when it falls back into the resting position. A ratchet lever *Q* is arranged to prevent the swinging to and fro of the drum head before it takes up its next filling position.

In order that varying pressures and sudden shocks may not cause a chamber to be discharged before it contains its full weight of water, the inlet valve in the collecting tank is divided into two passages controlled by hinged flaps *E* and *F*. These flaps are opened and closed by the motions of the lever *R*, which has a projection gliding on three noses on the drum head. When the weight of water causes the weight *L* to lift slightly, the projection *S* glides down on to a step on the nose *T*. This closes the large opening *E* of the inlet, leaving only the small one open, until the little step on *T* is also slipped by the lever *S*, when the smaller opening *F* is also closed and the water is entirely shut off for the moment. Thereafter the drum chamber *G* discharges, the chamber *J* comes into position, and the nose *U* opens both inlets again simultaneously, and so on.



DETAILS OF THE FEED-WATER WEIGHER

Each upward movement of the lever *R* is recorded on the counter, which is graduated in pounds of water. The meter is made in six standard sizes, and in the smallest of these each compartment of the drum holds one gallon. The normal speed of the meter is ten fillings per minute. The cam V is designed to arrest the weight *L* if it should rise before the full weight of water is contained in the filling chamber.

Each meter is provided with a controlling device to enable the user to ascertain at any time whether the drum is still being released by the correct weight of water. This consists of the levers *W* and the small bucket *X*. When the bucket is suspended, as shown by the dotted lines, and filled with water to the level of the lower collar, it should cause the lever *R* to close the large flap. When filled to the higher level it should release the drum. It is pointed out that the accuracy of the meter may by this method be checked as readily as that of a weighbridge. An overflow may be arranged in the collecting tank to render overstraining of the meter impossible. Pneumatic buffers and ball bearings are employed wherever possible, so as to reduce wear to a minimum, and to render the working of the meter almost noiseless.

We are informed that in order to test the accuracy of one of these meters, a tank into which it was delivering was arranged on a weighbridge which had previously been accurately proved by means of test weights. Periodically when full the tank was weighed, and it was found that on a four hours' continuous test the meter showed an average error of 0.48 per cent.

Self Contained Turbine Pumping Engine

The improvements made in centrifugal pumps and in steam turbines during recent years have permitted combining the two, forming a combination which compares favorably as to size, cost, simplicity, and steam consumption with reciprocating units.

Such a combination is adapted for driving a centrifugal pump where the service requires it to work against more than one pressure. This requirement is easily met with good steam economy by a turbine-driven multistage centrifugal pump properly arranged for series and parallel operation.

The combination turbine and pump is illustrated herewith. It consists of two 10-inch De Laval double-suction centrifugal pumps, driven by a De Laval steam turbine, and is arranged so that the pumps can be operated either in parallel or in series, then covering a range of operation from a normal delivery of 7550 gallons per minute against a 50-foot head to 2100 gallons per minute against a 175-foot head. The pumps are operated in parallel up to 80 feet. Above this range the two pumps are operated in series.

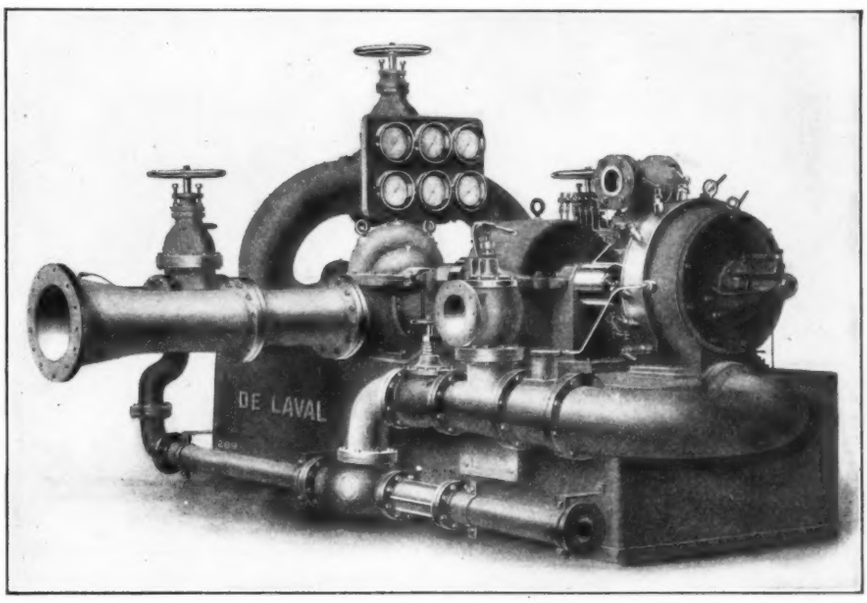
The pump, turbine and condenser are mounted on a box bedplate of moderate size. The condenser is of the ejector type, receiving the injection water under considerable head from the first pump, making possible a good vacuum with simple and inexpensive apparatus. If it is desired to shut off the condenser, the unit can be operated noncondensing by closing the water check valve in the exhaust pipe, when the steam will escape through the exhaust relief valve.

The exhaust pipe also contains a speed-limiting device to prevent the turbine running away in case of failure of the main governing valve. This emergency speed-limiting device consists of a butterfly valve in the exhaust pipe normally held open by a spring, but controlled by a piston. If the turbine exceeds a certain speed a governor on one of the gear shafts will open a valve admitting air behind the piston, which will then turn the butterfly valve to a position athwart the exhaust-steam pipe. As soon as the speed is checked the air will leak from the cylinder into the exhaust pipe, whereupon the valve will resume its normal position. When a constant water pressure or a constant excess of water pressure is desired, an ordinary pump governor can be installed in the steam line, in which case the main governor serves merely as a speed control.

All gages have been brought together upon a gage board attached to the piping connecting the two pumps. These gages show the steam pressure on the turbine throttle, the steam pressure above the nozzles, the water pressure in the pipe lines, the suction lift, the water pressure in the injection pipe to the condenser, and the vacuum.

Lubrication is furnished from a central multiple oiler mounted on the gear case of the turbine, the oil from this lubricator being used for the high-speed bearings, gears and governor pins. All oil from these points is carried to a common reservoir in the bedplate and from there pumped by separate oil pumps to an oil tank or filter mounted on the wall, from which it flows back to the central multiple oiler.

The unit is compact and completely self-contained, and only steam and water-piping connections are necessary to be made. The machine is set on a suitable foundation, which may be comparatively light, there being no vibration. This unit is built by the De Laval Steam Turbine Company, Trenton, N. J.



SELF-CONTAINED TURBINE PUMPING ENGINE

The Swartwout Automatic Safety Water Gage

The Swartwout automatic safety water gage, manufactured by the Ohio Blower Company, 332 Prospect avenue, Cleveland, O., greatly eliminates the dangers resulting from broken gage glasses.

In each of the two gage bodies there is an automatic valve held away from its seat while in use by a spring, shown at *F*, Fig. 1. In case of breakage this valve is closed quickly by the steam pressure in the boiler. The valve is also controlled by the handwheel so that both valve and valve seat are easily removed for cleaning without disturbing the gage at the boiler connections and without removing the packing of the gage glass.

As shown in the sectional view, the screw *E* holds the parts of the valve together, and when taken out, all the parts are released. At the inner end of the valve stem *C*, a flat scraper *D* loosens

any sediment adhering to the boiler connection, and as it revolves with every turn of the handwheel the opening is cleared frequently. The removable valve case *A* is provided with two external threads of the same pitch but of different diameters, so that the threads on the

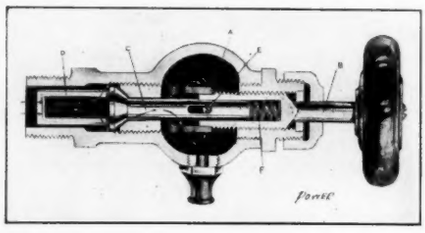


FIG. 1. SECTIONAL VIEW OF VALVE

inner end may slip by the outer internal thread when inserted. The threads are cut so that both sets engage the threads of the gage body at the same time, thereby insuring a good fit.

On replacing a broken glass the handwheel is turned forward until the valve is forced from its seat, thus allowing

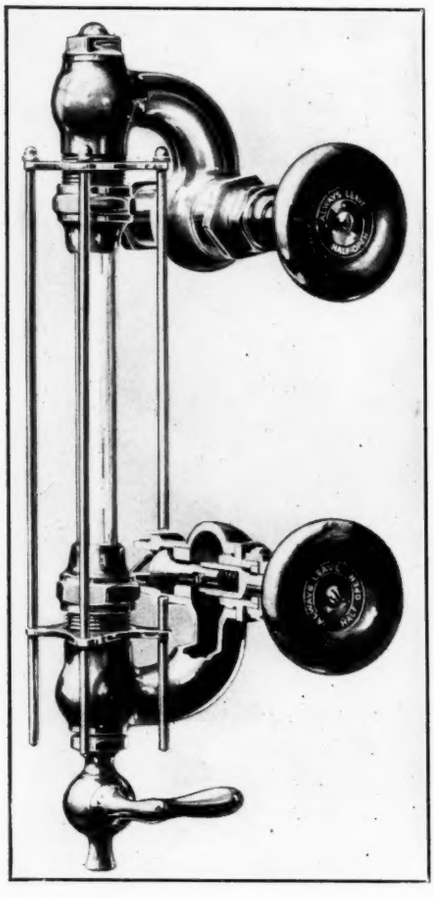


FIG. 2. SWARTWOUT SAFETY GAGE

water or steam to flow from the boiler into the gage glass; the valve on the other gage body will then automatically open to equalize the pressure. In turning the handwheel forward to force the valve from its seat, the movement of the spring *F* in stem *B* must first be taken up before the valve moves. Every turn of the wheel turns the valve upon its seat. In this way each valve is reground automatically.

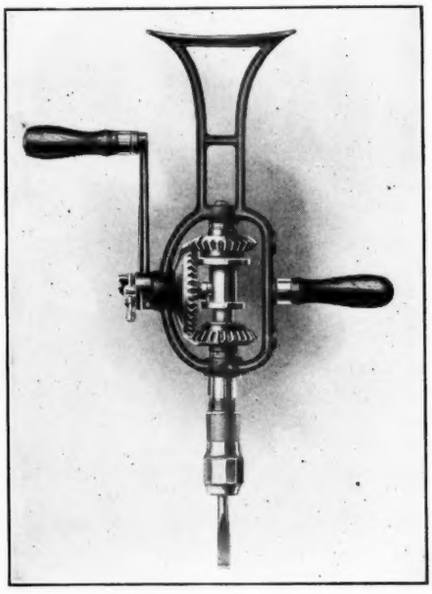
When the valve case is removed there is an unobstructed 1-inch opening into the boiler, obtained without in any way disturbing the gage bodies.

Another feature is the gooseneck gage body. This form of construction renders the operation of replacing a broken glass an easy task. It is inserted through either the top or bottom of the gage-glass holder, and need not be of any particular length, an inch or more making no difference. By removing the top plug or the drain cock at the bottom, the swab used for cleaning is easily inserted, without in any way disturbing the valves or gage bodies.

These devices are made extra heavy to withstand a pressure of 250 pounds per square inch. They are adapted to all types of boiler, also for marine, locomotive, stationary and portable service.

A Combination Valve Grinder, Breast Drill and Ratchet

The illustration shows a combined valve grinder, breast drill and ratchet designed to meet the demand for such a



COMBINATION GRINDER DRILL AND RATCHET

tool. The oscillating action for valve grinding is in an arc of a circle, not uniform, so many degrees to the right and so many degrees back, but steadily advancing to the right it does not travel twice consecutively over the same path.

The ratchet is both right or left hand as desired.

This tool is made by the Ashcroft Manufacturing Company, 85 to 89 Liberty street, New York City.

The Morrill Act and Engineering Education*

The Morrill bill authorizing the United States Government to endow "Colleges of Agriculture and the Mechanic Arts" became a law in 1862.

Prior to that time, engineering was taught at only three institutions in this country: Rensselaer Polytechnic at Troy and the Lawrence and Sheffield scientific schools at Harvard and Yale, respectively. The instruction at Troy was mostly if not entirely along the lines of civil engineering, while that at Harvard and Yale was probably of a decidedly academic and unpractical character.

The readiness with which the legislatures of the several States responded to the overtures of the Government is shown by the fact that before 1870, eleven institutions had begun work under this arrangement. In the next ten years, eight more State colleges were added to the list, and the same number between 1880 and 1890. There are now between forty and fifty institutions which profit by Government partnership.

Prior to the inauguration of this movement, engineering was not regarded as a profession but was rather a business or a trade.

A college education was a luxury and was confined to the few. The father of a family, large or small, sent his oldest son to college as his concession to the demand for a higher education. It was, however, with the understanding that this son was destined for one of the so called learned professions such as law, medicine, teaching or the ministry. The son who was of a mechanical turn of mind finished his education in the public schools and learned his trade or his business in practical work.

When the first colleges of agriculture and the mechanics arts were started, many educators looked askance at the idea of educating machinists and engineers. Frequent attempts were made by old established colleges to secure this Government aid and to annex technical instruction to their curricula. Fortunately for the cause of engineering education, the great majority of the colleges were organized on an independent basis.

As a student and afterward as a teacher in the Maine State College, one of the first four to take advantage of the new way, I can speak feelingly of the newness and crudeness of it all. Of the scarcely veiled contempt of the older colleges and their reluctance to acknowledge the new sister as legitimate. Of the uncertainty and timidity of all concerned in the new venture—uncertainty as to what to teach and how to teach it, timidty in occupying the educational field and putting technical studies in place of

*Read by Dean C. H. Benjamin, at Purdue University on April 14, the hundredth anniversary of Senator Morrill's birth.

philosophy and the dead languages. Nothing but the specific language of the act framed by Justin Morrill saved many of the institutions from educational shipwreck. There were no laboratories, no shops, just books and blackboards, a little drawing and some field work. And after graduation, the embryo engineer had an uphill road. He knew but little of his profession and he got less credit for what he did know. His employer was a self-made man, a graduate of the shop or the field and put slight confidence in the book knowledge of the beginner.

Even under these disadvantages the technical graduate held his own and slowly but surely forged to the front. The rapid development of manufacturing projects which followed our civil war, the enormous growth of railways and the exploiting of our natural resources in coal, oil, gas and iron ore, called continually for men with healthy bodies and trained minds.

Technical education gradually got its true bearings, realized its deficiencies and remedied them. Testing laboratories were equipped, shops were built and the student given a training which fitted him directly for his life work.

Electricity awoke and stirred herself, began to light streets and buildings, to propel cars and to carry the human voice. Men were needed to guide and control the newly discovered energy and the electrical engineer came into his inheritance. The manufacture of commercial products on a large scale called for men to plan and to execute and the chemical engineer stepped forward into prominence. And so from year to year the increasing development of our country and her natural resources have created a demand for just the sort of men that the technical college can supply. The colleges have increased in numbers and in size at a rate which could only have been justified by the demand for their product. That the demand is a healthy one can be shown by the steady and remunerative employment afforded the graduates.

That the education is practical and thorough can be shown by the advance of many of these same graduates to positions of trust and responsibility. The trade has become a profession and it is now an admitted fact that college training is as essential for the engineer as for the lawyer, the doctor or the minister. There are still a few growlers who ridicule the college graduate but they are the exception and we can afford to let them growl.

And whence came this great change in our educational system? A change which has made the college a part of that system, a natural sequence of the high school, and has opened the way for every boy of ordinary ability and ordinary opportunities. It came from the foresight of that wise legislator whose memory we honor today.

It is true that there are other colleges, other technical schools giving these same opportunities, but the onward movement in its inception and in its larger sense is due to the passage of a bill establishing colleges of agriculture and the mechanic arts, and the author of that bill was Justin Morrill.

Far reaching as its effects have been, we can now see but the beginning, and when one hundred years hence other students and other faculties gather in Fowler hall to celebrate the second centennial of Morrill's birth, the account will have swelled at compound interest to many times its present proportions.

NEW PUBLICATIONS

REGULATIONS FOR THE CONSTRUCTION AND INSPECTION OF BOILERS. Issued by the Government of the Province of Alberta. Obtainable from James E. Richards, government printer, Edmonton. 57 pages; 3x5½. Red morocco cover. Price, 25 cents.

The regulations which went into effect February 1, 1910, are a model of brevity and completeness. The rules were compiled by the department of public works for the purpose of insuring a uniform system of construction and safe rating of all boilers built or operated within the Province of Alberta.

The law, besides providing for the use of only reasonably safe boilers, stationary or portable, whether built in the province or elsewhere, also provides for the inspection of the piping auxiliaries and appliances in all power plants, and an examination into the general condition as regards protection of life and property from open flywheel pits, excessive speed of flywheels and pulleys, exposed set screws, keys, etc.

It is stipulated that all drawings and specifications for new boilers shall first be submitted for approval and registration, for which a nominal charge is made. In the case of boilers already built or those entering the province as settler's effects, a reduction is made in the allowable working pressure, the extent of which is left to the discretion of the inspector.

On all boilers complying strictly with the regulations a factor of safety of 4 is allowed, while for slight variations the inspector is allowed a wide range of discretion. In internally fired boilers with tubes other than ordinary fire tubes, all types are considered and formulas for the calculation of allowable pressures furnished.

Part of the expense of the inspection department will be borne by fees paid by the owners which range from $3 for the inspection of boiler accessories such as safety and stop valves, gages, etc., up to $10 each for locomotive, water-tube or horizontal return-tubular boilers above 42 inches in diameter, with additional fees up to $10 for the piping in a 1000-horsepower plant.

Among the specific provisions is the statement that no welded steel stays shall be allowed and that no stay shall be less than ⅞ inch in diameter; the maximum working stress to be 9000 pounds per square inch in the case of steel stays and 7000 for iron stays. The minimum thickness for boiler plates is set at ¼ inch and 72 inches is fixed as the maximum diameter allowable in any externally fired boiler.

It is further provided that no greater pressure than 175 pounds per square inch shall be allowed on any traction or portable boiler, regardless of its strength.

Under the heading of "fittings," the regulations provide that there shall be at least one fusible plug which shall project ⅜ inch through the sheet. It is a question whether best practice does not also require a plug to be inserted in the flue of externally fired boilers.

There are a few cases in the text where the statements are somewhat confusing although the underlying meaning is obvious. For instance, at the bottom of page 15, in speaking of the efficiency of a ligament, it states that "when a shell or drum is drilled for tube holes in a line diagonal with the axis of the shell or drum, etc." Here, while it is obvious that the tubes are diagonal with the axis, the text might be construed to mean that the line of holes was diagonal with the axis.

Again on page 19 it refers to pages 5 and 6 for a table of symbols, but there is no such table on those pages.

The province is to be congratulated on the completeness and intelligence with which the subject has been covered.

OBITUARY

The Late Milton Davis

Nobody can investigate the early history of the steam engine in America without becoming familiar with the part that Mr. Davis and his associates at Salem, O., played in developing this indispensable machine. Mr. Davis, who died on Tuesday, March 15, 1910, at his home in Salem, O., was born at Atwater, Portage county, O., December 12, 1822, and was a son of Isaac and Mary Davis who came to Columbiana county from North Carolina in the year 1806. Credit for the building up of Salem's largest industrial concerns, the Buckeye Engine Company, the Salem Wire Nail Company, and of its electric-light and street-railway systems, is due in a great measure to Mr. Davis' means and enterprise. For the past 67 years he had been a resident of the above city and his death is keenly felt by the manufacturing and business interests there.

He early learned the carpenter's trade with his father and continued to work at this in connection with some farming until 1843, when he came to Salem and entered the works of the Sharp brothers to learn pattern making. In this he became very proficient and later his main business was as draftsman and pattern maker, also going out to set up engines in different parts of the country, which the Sharp brothers were building with success at this time.

In 1849 the Sharp brothers, Simeon and Joel, formed a partnership with Mr. Davis and Joel S. Bonsall, and organized a new firm under the name of Sharps, Davis & Bonsall for the manufacture of high-speed engines. The members of the firm were all practical mechanics and did much of the work themselves, a force of twelve men only being required in the establishment. In December, 1870, the present Buckeye Engine Company was incorporated, with Milton Davis as vice-president. For over 20 years Mr. Davis had charge of the pattern department and much of the success of the enterprise came from his mechanical ability and accuracy. In 1895 he retired from the office of vice-president. Previous to this time, in 1888, Mr. Davis established the Salem Electric Light and Power Company, erected the plant on Locust street, and with his sons controlled it. In the year 1892 he became interested in the Salem Street Railway Company, becoming its financial backer, and until the time of his death was president and treasurer of that company.

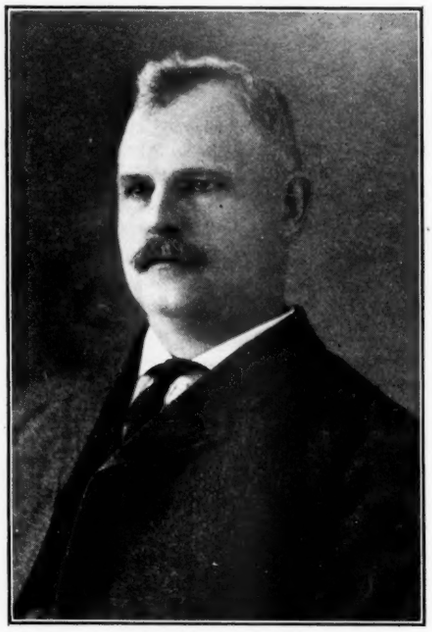
In 1850 Mr. Davis was married to Miss Sarah Anthony, who died in 1865. Three children were born to this union, two sons, D. W., and D. L., and one daughter who died in 1874. The two sons, both residents of Salem, survive, together with a brother, Dr. A. A. Davis, of Eugene, Oregon, and a half-sister, Mrs. Nettie Heacock, of Gresham, Oregon.

Mr. Davis will always be remembered as one of a group of pioneers who have made Salem famous for its part in the development of the high-speed automatic engine.

Ernest P. Sparrow

On April 18, Ernest P. Sparrow died at Boston, Mass. He was born at Greenville, Me., in 1857. He received his engineering education at the Worcester Poltechnic Institute from which he graduated in the 'eighties. His first business connection was with the Electric Light Company, of Portland, Me. After severing his connection with this company he engaged in erecting work for the Fitchburg Steam Engine Company. Later, he became associated, successively, with the Mather Electric Light Company, the Thomson-Houston Electric Company and the Jarvis Engineering Company.

From 1893 to 1896, Mr. Sparrow was erecting superintendent for the Edward P. Allis Company. He left this company to become master mechanic of the Boston Rubber Shoe Company. Subsequently he was connected with the New Brunswick Rubber Company, James Beggs Company and, for a short time, with



ERNEST P. SPARROW

Brown & Sharpe. At the time of his death he had been engaged in some special engineering work for the B. F. Sturtevant Company for several years.

Mr. Sparrow had been a member of the American Society of Mechanical Engineers since 1896, and was a man of exceptional ability and mental equipment. He is survived by his wife and one daughter.

Robert Fulton Association No. 57, National Association of Stationary Engineers, of Brooklyn, has sustained a loss in the death of past president Charles F. Brady. A widow and four children survive him. It was regularly moved and seconded that a letter of sympathy be sent to the widow, and that the charter be draped for thirty days.

SOCIETY NOTES

The provisional program for the joint meeting of the American Society of Mechanical Engineers with the Institution of Mechanical Engineers has recently come to hand and is as follows:

PROVISIONAL BIRMINGHAM PROGRAM

MONDAY, JULY 25. Arrival in Birmingham

TUESDAY, JULY 26

Morning—The Right Hon. the Lord Mayor of Birmingham and the members of the local committee will receive and welcome the president, George Westinghouse, Esq., and the officers and members of the American Society of Mechanical Engineers, and the president, John A. F. Aspinall, Esq., and the council and members of the Institution of Mechanical Engineers.

Reading and discussion of papers.

Luncheon in the town hall.

Afternoon—Visits to Stratford-on-Avon, Worcester, Gloucester, or Bournville; and local works.

Evening—Garden fête.

WEDNESDAY, JULY 27

Morning—Reading and discussion of papers.

Luncheon in the town hall.

Afternoon—Visits to the university; and local works.

Evening—Reception in the council house, by invitation of the Right Hon. the Lord Mayor of Birmingham.

THURSDAY, JULY 28

Visits to works in Coventry and Rugby; also to Warwick, Leamington, Kenilworth, or Lichfield.

PROVISIONAL LONDON PROGRAM

THURSDAY, JULY 28

Evening—Conversazione at the institution.

FRIDAY, JULY 29

Morning—Reading and discussion of papers.

Afternoon—Garden parties at private houses.

Evening—Institution dinner in the Connaught rooms, Freemasons' hall, Great Queen street, W. C. (including ladies).

SATURDAY, JULY 30

Morning and Afternoon—Excursion by rail and river to Windsor and Henley.

Evening—Reception at the Garden Club in the Japan-British Exhibition at the White City.

It is intended that invitation cards be handed to the American visitors on their arrival in Birmingham. The privileges and invitations in connection with the meeting are personal and are not transferable.

At the meeting of the Ohio Society of Mechanical, Electrical and Steam Engineers to be held from May 19 to 21, at Cincinnati, the following papers will be presented: "Selecting a Boiler," by F. C. Bitgood; "The Scientific Treatment of Boiler Feed Water," by Herbert E. Stone; "Metallurgical Considerations in the Manufacture of High Pressure Valves and Fittings," by George K. Elliott; "Centrifugal Pumps—Their Uses and Limitations," by L. G. Finlay; "The Kinney Positive Pressure Rotary Pump," by C. O. Thurston.

PERSONAL

F. L. O. Wadsworth, consulting and advisory engineer and expert in patent causes, Pittsburg, Penn., announces the removal of his general consulting offices from Sewickley to the Oliver building, rooms 1347-8. Laboratories remain in Sewickley.

NEW INVENTIONS

Printed copies of patents are furnished by the Patent Office at 5c each Address the Commissioner of Patents, Washington, D. C.

PRIME MOVERS

WATER MOTOR. John H. Hendrickson, Cleveland, Ohio. 954,433.

GAS ENGINE. William L. Morrow, Stockton, Cal. 954,577.

SPRING MOTOR. Charles H. Von Hohenstein, San Antonio, Texas, assignor by mesne assignments to the International Spring Motor Company, a Corporation of Nevada. 954,602.

ROTARY ENGINE. Ernst A. Bohm, San Bruno, Cal. 954,609.

CURRENT MOTOR. John I. Hawley, Plymouth, Wash. 954,626.

TURBINE ENGINE. William Fennell, Wednesbury, England. 954,946.

ENGINE. Felix Manz, Pittsburg, Penn., assignor of one-half to Fred W. Stangee, Pittsburg, Penn. 954,982.

WATER-CURRENT POWER SYSTEM. Cornelius F. A. Roell, Independence, Mo. 954,999.

BOILERS, BURNERS AND FURNACES

DOWNDRAFT SECTIONAL BOILER. Elijah M. Bosley, St. Louis, Mo. 954,417.

AUTOMATIC CUTOFF FOR VAPOR BURNERS. Sigge Stenberg, Sundbyberg, Stockholm, Sweden. 954,477.

APPARATUS FOR SUPERHEATING STEAM. Henry Cruse, Salford, England. 954,501.

OIL BURNER. Emmerson N. Shaw, Vallejo, Cal. 954,652.

MECHANICAL STOKER. John A. Caldwell, Montclair, N. J. 954,717.

SUPERHEATER. John E. Bell, Barberton, Ohio, assignor to the Babcock & Wilcox Company, New York, N. Y., a Corporation of New Jersey. 954,913.

CRUDE-OIL BURNER. Arthur J. Hennessey, St. Louis, Mo. 954,959.

POWER PLANT AUXILIARIES AND APPLIANCES

CARBURETER. Austin M. Wolf, New York, N. Y. 954,488.

FLEXIBLE PIPE JOINT. George F. Barron, Palmyra, N. Y. 954,496.

PIPE COUPLING. Warren F. Drew, New York, N. Y. 954,504.

AIR AND GAS MIXER FOR EXPLOSIVE ENGINES. Geo. L. Fogler, Baltimore, Maryland, assignor to Harry B. Bryson, Pittsburg, Penn. 954,507.

VALVE HANDLE. Walter P. Marble, Cambridge, Mass. 954,533.

PIPE COUPLING. William A. Turner, Providence, R. I., assignor of one-half to Joseph C. Hartwell, Providence, R. I. 954,549.

LUBRICATOR. Chester J. Van Doren, Chanute, Kan., assignor by mesne assignments, to Alice M. Van Doren, Grand Rapids, Mich. 954,600.

CARBURETER. Albert Howarth, Providence, R. I., assignor to Star Carbureter and Supply Company, Providence, R. I., a Corporation of Rhode Island. 954,630.

GOVERNING MECHANISM. Millard M. Pearson, Schenectady, N. Y., assignor to General Electric Company, a Corporation of New York. 954,646.

SPARK PLUG. Herbert F. Provandie, Boston, Mass., assignor of one-half to the Randall-Faichney Company, Boston, Mass., a Corporation of Massachusetts. 954,697.

SAFETY APPLIANCE FOR STEAM BOILERS. Eugen Roth, Schoneberg, near Berlin, Germany. 954,764.

CARBURETER. Horace O. Craven, Schenectady, N. Y. 954,785.

ELECTRICAL INVENTIONS

MEANS FOR SUPPRESSING THE RESISTANCE OF THE NEGATIVE-ELECTRODE FLAME IN ELECTRIC VAPOR APPARATUS. Peter C. Hewitt, New York, N. Y., assignor by mesne assignments, to Cooper Hewitt Electric Company, a Corporation of New York. 954,434.

TERMINAL FOR PUSH-BUTTON ELECTRIC SWITCHES. Norman Marshall, West Newton, Mass., assignor to the Arrow Electric Company, Hartford, Conn., a Corporation of Connecticut. 954,448.

ELECTRIC SWITCH. Johann G. Peterson, Hartford, Conn., assignor to the Arrow Electric Company, Hartford, Conn., a Corporation of Connecticut. 954,462.

ELECTRIC SWITCH HANDLE. Johann G. Peterson, Hartford, Conn., assignor to the Arrow Electric Company, Hartford, Conn., a Corporation of Connecticut. 954,463.

WINDING FOR ELECTRIC MACHINERY. Heinrich Rosenberg, Vienna, Austria-Hungary, and Emanuel Rosenberg, Berlin, Germany. 954,468.

MISCELLANEOUS TOOLS

WRENCH. Gustaf Johnson, Chicago, Ill. 951,398.

WRENCH. Zacharier M. Paul, Fort Worth, Tex. 951,219.

PIPE WRENCH. William S. Miehle, Chicago, Ill. 951,570.

RATCHET WRENCH. Joseph C. Heinrich, and William Kellerman, Philadelphia, Penn. 951,316.

WRENCH. George A. McIntire, Port Chester, N. Y., assignor to Perfection Wrench Company, a Corporation of New York. 952,079.

WRENCH. Benjamin W. Woodward, Ipswich, Conn. 952,223.

WRENCH. Henry Julich, Mount Hope, Wis. 952,261.

WRENCH. Henry Hand and Townson Hand, Seattle, Wash., said Henry Hand assignor to said Townson Hand. 952,327.

State Conventions

POWER has written to the secretaries of the several State associations of the National Association of Stationary Engineers requesting particulars regarding their conventions for 1910. Up to the time of going to press the associations of Indiana, Texas and West Virginia have not replied. Following are the dates and places of the annual meetings of the State associations from whom we have heard:

Iowa, at Waterloo, May 5, 6 and 7.

Illinois, at Moline, May 21.

California, at Los Angeles, May 23 to 28.

Pennsylvania, at Scranton, June 3 and 4.

New Jersey, at Jersey City, June 4.

Colorado, at Denver, June 10.

Kentucky, at Hopkinsville, June 10 and 11.

New York, at Buffalo, June 10 and 11.

Ohio, at Hamilton, June 16, 17 and 18.

Wisconsin, at Oshkosh, June 17, 18 and 19.

Connecticut, at New Haven, June 24 and 25.

Massachusetts, at Lowell, July 7, 8 and 9.

Michigan, at Kalamazoo, July 21, 22 and 23.

Canadian Association of Stationary Engineers at Berlin, Ont., July 26, 27 and 28.

ENGINEERING SOCIETIES

AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Pres., George Westinghouse; sec., Calvin W. Rice, Engineering Societies building, 29 West 39th St., New York. Monthly meetings in New York City. Spring meeting at Atlantic City, May 31 to June 6.

NATIONAL ELECTRIC LIGHT ASSOCIATION

Pres., Frank W. Frueauff, Denver, Colo.; sec. and treas., Frank M. Tait. Association York. Next annual convention, St. Louis, Mo., May 23-28.

AMERICAN SOCIETY OF NAVAL ENGINEERS

Pres., Engineer-in-Chief Hutch I. Cone, U .S. N.; sec. and treas., Lieutenant Henry C. Dinger, U. S. N., Bureau of Steam Engineering, Navy Department, Washington, D. C.

AMERICAN BOILER MANUFACTURERS' ASSOCIATION

Pres., E. D. Meier, 11 Broadway, New York; sec., J. D. Farasey, cor. 37th St. and Erie Railway, Cleveland, O.

WESTERN SOCIETY OF ENGINEERS

Pres., J. W. Alvord; sec., J. H. Warder, 1735 Monadnock Block, Chicago, Ill.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA

Pres., E. K. Morse; sec., E. K. Hiles, Oliver building, Pittsburg, Penn. Meetings 1st and 3d Tuesdays.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Pres., L. B. Stillwell; sec., Ralph W. Pope, 33 W. Thirty-ninth St., New York. Meetings monthly, excepting July and August.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.

Pres., Prof. J. D. Hoffman; sec., William M. Mackay, P. O. Box 1818, New York City. Next semi-annual meeting, St. Louis, Mo., June 30 and July 1, 1910.

NATIONAL ASSOCIATION OF STATIONARY ENGINEERS

Pres., William J. Reynolds, Hoboken, N. J.; sec., F. W. Raven, 325 Dearborn street, Chicago, Ill. Next convention, Rochester, N. Y., September, 1910.

UNIVERSAL CRAFTSMEN COUNCIL OF ENGINEERS

Grand Worthy Chief, W. S. Cadwell, Chicago, Ill.; sec., Thomas H. Jones, 244 Eighth street, N. E., Washington, D. C. Next convention, Buffalo, N. Y., August 2-5, 1910.

AMERICAN ORDER OF STEAM ENGINEERS

Supr. Chief Engr., Frederick Markoe, Philadelphia, Pa.; Supr. Cor. Engr., William S. Wetzler, 753 N. Forty-fourth St., Philadelphia, Pa. Next convention, Philadelphia, Pa., June 6-10, 1910.

NATIONAL MARINE ENGINEERS BENEFICIAL ASSOCIATIONS.

Pres., William F. Yates, New York, N. Y.; sec., George A. Grubb, 1040 Dakin street, Chicago, Ill. Next meeting, St. Louis, Mo., January 16-21, 1911.

OHIO SOCIETY OF MECHANICAL, ELECTRICAL AND STEAM ENGINEERS

Pres., O. F. Rabbe; sec. and treas., Prof. F. E. Sanborn, Ohio State University, Columbus, Ohio. Next meeting, Cincinnati, May 19 and 20, 1910.

INTERNATIONAL MASTER BOILER MAKERS' ASSOCIATION

Pres., A. E. Brown; sec., Harry D. Vaught, 95 Liberty street, New York. Next meeting at Niagara Falls, Canada, May 24-27, 1910.

INTERNATIONAL UNION OF STEAM ENGINEERS

Pres., Matt. Comerford; sec., Robert A. McKee, 606 Main St., Peoria, Ill. Next convention, Denver, Colo., September, 1910.

NATIONAL DISTRICT HEATING ASSOCIATION.

Pres., A. C. Rogers, Toledo, O.; sec. and treas., D. L. Gaskill, Greenville, O. Next annual meeting at Toledo, O., May, 1910.

MOMENTS WITH THE Advertising Editor

A Department *for* Subscribers Conducted *by the* Business End *of* Power *and the* Engineer

Mount Clemens, Michigan, has a unique way of collecting an advertising appropriation, and since it is the only authentic case that we know of where "the consumer pays the bill," it is worth recording.

Mount Clemens is famed, and justly so, for the curative powers of its mineral springs.

It is the City of Symptoms and the temporary abode of those derelicts who have found the way of the transgressor easy—and the return trip hard.

You arrive there with crutches and cane and come away with the latter metamorphosed into a "swagger stick."

The system is strenuous but effective. You don't drink the water, you wallow in it. You're turned over to the tender mercies of a tough attendant and he turns you into a tub of stuff that looks like ink and smells like—well, nothing this side of a cold storage egg, "of a vintage," resembles it.

First, however, you consult a physician—the population is made up of doctors and hotel keepers—and his initial question is, "What have you got?"

"Thirty dollars," you reply.

"Go home and get some more," says he. Which explains why the doctors live in palaces on Cass Avenue and why one of them is just finishing up a castle that looks like the middle ages in front and the dark ages behind.

However, good health, like good machinery and good advertising, isn't a matter of *cost* but of *results*.

And, since Mount Clemens "delivers the goods," the cost of delivery is of no moment.

Now, be it known that they sell a cigar in that town which comes in a box prominently labeled, "Not made by a trust. Not advertised."

"Why," we gently ask the cigar man, "why do they make the boast 'not advertised'"?

"Because," he answers, "they put the money ordinarily spent for advertising into the quality of the cigar."

It comes out glibly as though he had been well coached for the part.

Here, we think, is the opportunity to put the acid test onto that frayed statement. So we select one of the "not advertised" cigars, and from another box pick one of the same size and price of an advertised brand that is known from coast to coast.

Then, lest we be prejudiced beyond fair judgment, we hand them both, with the life belts removed and without comment, to a third party and ask for an opinion.

"This is the better," says he, with a positiveness that amounts to conviction, as he hands back the remains of the *advertised* cigar.

Everlastingly, non-advertisers of everything from monuments to machinery seek to claim that the "consumer pays for the advertising."

As a matter of fact—and this is capable of proof had we the space—the non-advertiser indirectly pays for the advertiser's advertising!

"How many of the advertised brand of cigars do you sell to the non-advertised brand?" we later ask the cigar man.

"About ten to one," he admits.

Which is one glittering reason why the advertiser can give better quality for the same price and pay his advertising bills beside.

Remember this little example the next time somebody hands you that shredded statement, "the consumer pays the bill."

He doesn't—except in Mount Clemens. Which brings us back to the original idea expressed in the first paragraph.

Up there they license what are known as "Clubs" wherein the weary stranger is allowed to guess which pocket the little white ball will roll into. There are 38 pockets and only one little ball.

The "Clubs" pay $1200 per year apiece for their licenses and this money goes into the advertising appropriation for the town.

Then to make things certain they bar the townspeople and admit visitors only!

Oh, yes, in *Mount Clemens* the consumer, *he* pays.